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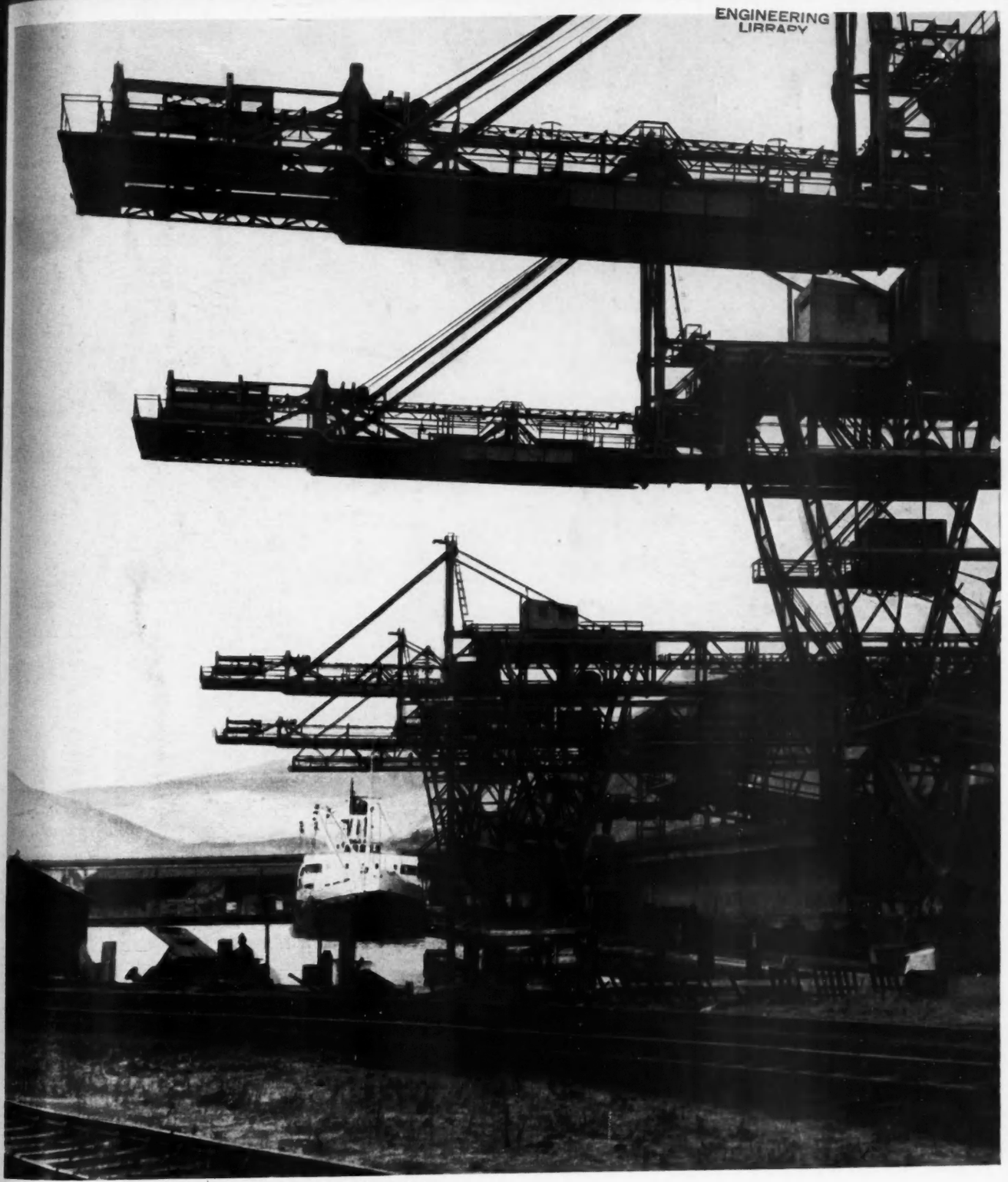

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ENGINEERING

An Illustrated Weekly Journal

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RESEARCH TYPES

THE enormous growth of scientific and industrial research in recent years has given a new urgency to the perennial problems of the administration of research and the choice and motivation of research workers. The particular nature of the work of those engaged in research beyond the routine level of inquiry, and the methods of their recruitment and organisation, have recently been the subject of two conferences: one on the "Direction of Research Establishments," organised by the Department of Scientific and Industrial Research and reported in this journal in a series of articles (see page 749); and the other under the title "Research is People" which took place at the spring meeting of the American Industrial Research Institute.

The high-pressure methods used in the United States to recruit young scientists from the universities (as described in the recently published report of the American meeting) are hardly calculated to give the young man starting on his first job that sense of humility on which all good scientific inquiry is based. On the other hand, there is a wide measure of agreement on both sides of the Atlantic on the broad qualities that are needed for research work and the motives which inspire the individuals who engage in it.

Most research work is to-day undertaken in groups and in these a judicious mixture of types is desirable. There are those who possess the ability and personality to solve, by generally orthodox methods, problems strictly formulated for them. There are men and women capable of performing the same tasks but who bring to them original ideas and methods. Finally, there are the truly creative individuals who recognise new problems, or problems whose existence others have only vaguely comprehended, and who are capable of formulating and solving them in ways of their own devising. These are the true inventors and producers of new ideas, less traditional and less dogmatic than their fellows and capable of visions which they believe they have the power to translate into achievement.

No doubt these different types are subject to different forms of motivation; with non-material incentives playing a larger part in the most creative groups. Recognition of good work, good personal relations and especially leadership in the laboratory and professional status appear to play the biggest part in the motivation of researchers everywhere, but the wish for freedom to select assignments plays a big part in the minds of many and distinguishes them from other workers.

In view of the general scarcity of scientific and engineering graduates it behoves those who employ them to ensure that those they recruit are best suited for their work and that they are employed to the full limits of their capabilities. Obviously, the method of competitive grabbing from the universities, without regard to suitability, is unsatisfactory; for even if it fills the places, the chances are that many of the new employees will be found unsuitable or will feel unsatisfied and so will leave. It is important, not only that the employer should be clear what he wants, but also that the student should be made aware of the nature of the organisation he is being asked to join, the work he will be required to undertake and the opportunities that will be available to him to pursue his particular interests. The need for a firm to "sell" itself to a prospective employee has grown in the past few years as a result of full employment; it may be an almost farcical situation, but at least it has encouraged firms to be precise in specifying their requirements for staff.

There is a danger, which was emphasised at the D.S.I.R. conference, that over-specialisation in early scientific education could be a handicap in team-work where a wide general grasp is needed in order that the researcher can co-operate with other scientists and if he is to have a knowledge of the field of requirements and so of what to "invent." This applies particularly in engineering where it is the present practice to educate students who are going into every field of activity in the same courses and where the continual advance of knowledge and techniques is overcrowding the curriculum to the point where a demand is arising for an extra year on the course.

This is not desirable for the average undergraduate, many of whom will find themselves fairly soon in the fields of management, production or sales. What is needed is to select those students who have the characteristics required for research work and to give them, after graduating, a year's advanced course in the special tools of their trade: in particular, mathematics and physics. These courses should clearly be based on instruction and not on actual laboratory research and should be aimed at turning the broadly trained engineer into a research specialist. There would still be need for post-graduate courses for a growing number of students in the rapidly advancing technologies; but many of these students will, in future, return to the university with more advantage after a period of work in the industry of their choice.

It is time that a serious study was undertaken of the personal characteristics needed for research work, both fundamental and

applied; perhaps it will thus be possible to make appropriate job analyses against which the suitability of those who wish to undertake research can be measured.

* * *

Plain Words

Consider the 11,000 Hungarian refugees who have come to Britain to find a new home. The Government's readiness to succour these unfortunate people is not only an act of mercy: it is a policy that historically has helped to make Britain a great nation. A similar policy has played a big part in putting the United States at the head of the industrial powers of the world. When men and women leave their native land in desperation and seek a refuge among strangers, they are born again; their hearts and minds are fired with a new will to succeed. Their hearts and minds are new assets to the country which receives them.

Among the first firms to offer hospitality were three Letchworth companies—the British Tabulating Machine Company, Limited; K. and L. Steelfounders and Engineers, Limited; and Borg-Warner, Limited—who have made available a large hostel for a number of Hungarian families. These three firms, together with Geo. W. King, Limited, of Stevenage, have co-operated in interviewing a considerable number of immigrants, most of them young single men. The youthfulness of the refugees is, in some cases, a temporary difficulty. At Geo. W. King's factory, for example, no Hungarians under the age of 21 can be taken because minors are only accepted as apprentices, and the Hungarians cannot be treated as apprentices. In all, these companies had absorbed about 20 men last week, four of whom are skilled craftsmen—three machine-tool setters and one electrician—the remainder being semi-skilled workmen engaged mostly in machine shop operations and assembly work. Hostels have also been offered by the National Coal Board in Nottinghamshire and Derbyshire, and there is a possibility that next year many Hungarians may be working in the mines. The National Union of Mineworkers have agreed to their employment in principle, subject to the approval of the local trade union lodges.

Regarding professional engineers, at least one well-known heavy engineering firm is ready to receive suitably qualified men, and has already placed a Hungarian in the design department. The Ministry of Labour and National Service, who are handling the occupational problems of the incoming refugees, have so far only some half-dozen professional Hungarians on their books. The Scientific and Technical Register has placed a Hungarian mining engineer with the National Coal Board at Nottingham, and is now making arrangements for one mechanical engineer, three electrical engineers, an architect and an agricultural scientist.

Language difficulties slow down the procedure for interviewing and placing these men, and until they have learnt our tongue some of them may have to be content with work of a somewhat lower standard than they are accustomed to. But the Hungarians will not regard their English classes as other than a minor hurdle. Some of them want to re-emigrate—to Canada, for instance—but we would be foolish not to give them every opportunity to find a niche in Britain. A few thousand Hungarians in our midst might give us a deeper sense of the bonds that could integrate us with Western Europe.

PHOTOGRAPHY AT 3,000 FATHOMS

BRITISH AUTOMATIC UNDERWATER CAMERA

Fig. 1 A squid takes bait from the underwater camera at 500 fathoms, and thereby triggers the camera and lighting circuits.

Earlier this year, in an article on "Instruments for Oceanography" (ENGINEERING, May 25, page 398), we referred to an underwater camera that had just reached the trial stage, developed by Dr. A. S. Laughton, of the National Institute of Oceanography, for securing photographic records of the ocean bed and its occupants and, also, for mid-ocean photography. The trials were carried through successfully and since then the camera has been in routine use on a geophysical cruise on board R.R.S. Discovery II in the eastern Atlantic and on a biological cruise in Norwegian and eastern Atlantic waters. Two of the more pictorial photographs obtained with the camera are shown in Figs. 1 and 2; an example of mid-ocean photography in Fig. 1, which is a fairly close-up view of a medium-sized squid—an elusive creature—at a depth of about 500 fathoms; and in Fig. 2 an ocean-bed photograph at 700 fathoms, on a rocky slope on the mid-Atlantic ridge. Loose shingle and boulders appear to have slid down the slope. The white patches are probably partly consolidated calcareous ooze. On the left centre can be distinguished variety of star fish known as a brittle star, about 6 in. in diameter.

The complete camera assembly (Fig. 3) consists of a framework, on which is suspended a bottoming weight used to actuate a triggering switch when it touches the sea bed; a light source; the camera itself, which takes single shots on 35 mm. film; and a magneto-striction coil which signals to the ship when the bottoming weight triggers the electrical circuits. The angle and position of the camera and of the light source can be adjusted, before lowering the assembly, to suit the expected configuration of the ocean floor. All the necessary electrical supplies are self-contained in the camera housing, the light-source housing and one of the hollow main side members of the frame. These frame members are, in fact, light-alloy tubular scaffold poles sealed at each end by end caps and O-rings and although they have withstood a test to the equivalent of 2,800 fathoms, or 7,000 lb. per sq. in., there is some doubt whether they can be consistently relied upon for ocean-floor work at over 3,000 fathoms (about 8,000 lb. per sq. in. pressure). The National Institute of Oceanography therefore intend to develop a stronger framework. The pressure-tight housings for the camera and the light source, on the other hand, have also been tested in the laboratory to 7,000 lb.

Fig. 2 An ocean-bed photograph on a rocky slope on the mid-Atlantic ridge. A brittle star can be distinguished about one-third of the width from the left and nearly half-way down.

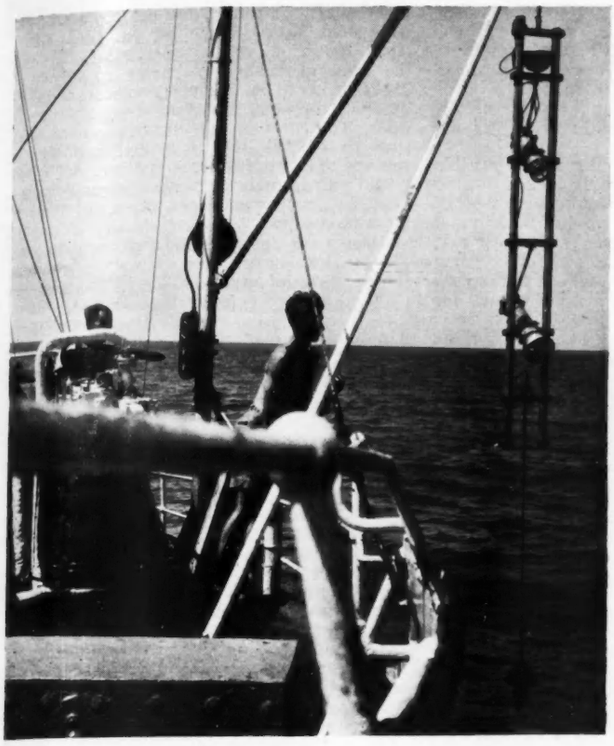

Fig. 3 The complete camera assembly comprising framework, suspended bottoming weight which triggers the operating circuits, light source, camera, and magneto-striction coil. The designer stands by as the camera is lowered.

per sq. in. but have a sufficiently high factor of safety to withstand up to 10,000 lb. per sq. in. without risk of collapse.

The watertight housings in which the camera and the light source are enclosed are similar in construction, that for the light source being slightly longer. Each comprises a cylindrical housing bored out from solid Duralumin bar 4½ in. in diameter to a thickness of ¾ in., closed at the rear end by a screwed end cap sealing on an O-ring. At the forward end the camera housing is sealed by a Perspex window seated on an O-ring. An extension frame and mounting ring in front of the pressure-tight casing houses a doublet lens for correcting chromatic aberration —this lens being exposed to the sea. This arrangement is more compact and permits the use of a simpler lens system than would be the case if the compensating lens were incorporated in the main optical system within the pressure casing.

The problem of making watertight joints for the electrical leads from the bottoming switch has been solved by the arrangement illustrated in Fig. 4. A brass machined socket set in Araldite resin, also machined, is screwed into the Duralumin watertight casing and is sealed with an O-ring. Inside, the socket mates with a contact on the camera or the light-source circuit, and outside it projects beyond the casing. The lead from the bottoming switch terminates in a rubber push-on plug with a hard core inset. Pushing the plug on to the Araldite projection forms an effective seal and provides the necessary electrical contact.

The bottoming switch is closed by the release of a compression spring which is compressed by the weight while the latter is in free water, but is released when the weight touches bottom and takes the tension off the weight cable. The closing of the bottoming switch completes the film-transport motor circuit and the flashlight circuit, and modifies the " pinger " circuit. The acoustic transmitter is, in fact, in action throughout the operation of lowering, reaching bottom, and raising, but operation of the bottoming switch steps up the pulse rate to inform the deck operators that the instrument is on the sea bed.

The circuitry for the " pinger " takes the form of an elongated package, encased in a polythene insulating skin. The main circuit components comprise condensers which discharge through a gas-filled tube imparting electrical pulses to the magneto-striction coil; the power pack consists of twelve 30 volt batteries. As already mentioned, the entire assembly is housed in one of the hollow scaffold poles.

The light source comprises a Mazda flash tube which is operated by the discharge of two 1600 mfd condensers at 270 volts. The power pack, plugged on to the rear of the condensers, consists of nine 30 volt batteries. The whole assembly is housed in the watertight casing, the front end of which is sealed by a Pyrex glass cap, about ¼ in. thick, cemented on to the metal casing with Araldite adhesive. The light reflector is mounted outside the casing.

The camera itself (Figs. 5 and 6), which fits into the watertight casing, has no shutter. The duration of the flash from the light source alone determines the length of exposure. Either a 3·5 cm. wide angle or a 5 cm. Dalmac lens is employed, with an aperture of *f* 3·5, the wide-angle lens being used for ocean-bed photography where it is desired to cover a wide area; the 5 cm. lens, on the other hand, provides a better definition and is generally used for mid-ocean fish portraits. Both lenses require the additional compensating lens to correct for the fact that the object is in

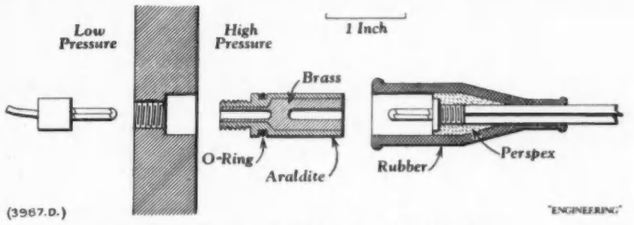

Fig. 4 Watertight joint for the electrical leads.

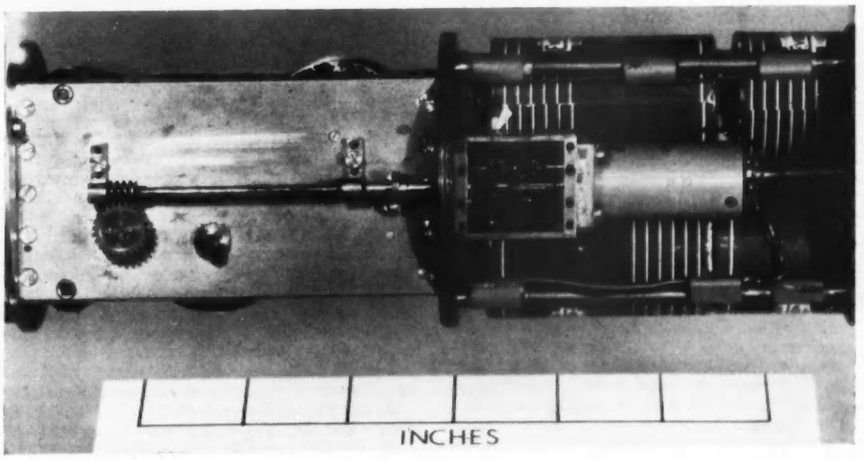

Fig. 5

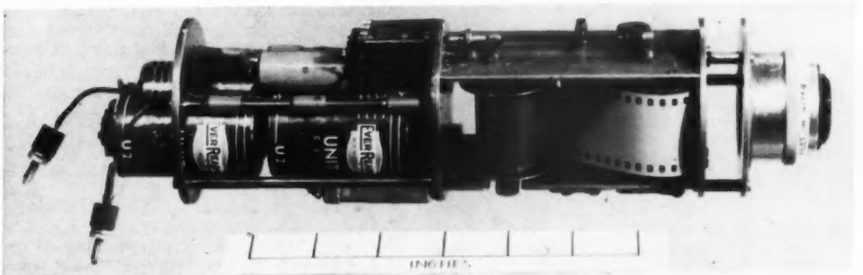

Fig. 6

Figs. 5 and 6 The camera unit comprises battery power pack, miniature electric motor, gearbox (visible in the underside view, Fig. 5), 100-frame roll of film, and 3·5 cm. or 5 cm. Dalmac lens. There is no shutter. When the triggering switch is operated the motor advances the film through one frame and is then stopped by a microswitch operated by a cam on the take-up spool. The light flash is triggered simultaneously.

water. The camera is loaded with a 100-frame roll of 35 mm. film. On operation of the triggering switch, the film is advanced through one frame by means of a 6 volt 7,000 r.p.m. Vactric motor, supplied by four 1½ volt cells, driving through a variable speed gearbox which provides three different rates of film advance—4 sec., 12 sec. and 50 sec. The slowest rate is provided for use when taking repeated observations of, for instance, instrument readings, to allow sufficient time for the flash lamp condensers to recharge.

The gear train, which is quite complex, was designed and manufactured by the Institute; enclosed in a brass frame with a Perspex cover it occupies a space of less than 1 cub. in. It can be seen in Fig. 6.

After the film has been advanced through one frame a cam on the take-up spool actuates a microswitch to stop the motor.

In the case of mid-water photography, a modified triggering arrangement is used. To the lower end of the camera assembly frame is attached a 10 ft. extension scaffold tube which carries an outrigger on the end of which is a hook loaded with bait. When a fish takes the bait, the hook operates the triggering switch initiating the camera sequence. As Fig. 1 shows, this technique has proved to be remarkably successful; nevertheless, the camera's designer is contemplating an alternative method using a photo-electric cell, detecting the passage of a fish across the camera's path, to trigger the operation.

The deep-water camera has many possible applications in oceanography. In addition to its uses for studying underwater life in mid-ocean and for surveying different types of bottom and of correlating their topography, geology and types of marine creatures, it is a useful recording tool for physical measurements such as deep sea temperatures and currents. One means for photographically measuring deep-ocean currents near to the sea bed that has been tried consists of releasing, from a syringe mounted on the frame, drops of neutrally-buoyant oil, and recording their possition at successive intervals. It is possible to fix the position of the oil globules in space by reference to their shadow on the sea bed, and thence to determine their true path.

Fig. 3 is reproduced by courtesy of the British Petroleum Company, Limited.

Letters to the Editor

ELASTIC STABILITY OF COLUMNS

SIR, The writer wishes to thank Mr. T. E. Leivers for drawing attention to several important matters in his letter that you published on December 7 (page 708).

It is true that Eaton Hodgkinson's column tests are not now taken to be conclusive evidence that a practical long column with restrained ends has an axial strength of about $3\,P_Y$, P_Y being the Euler load with the ends free. J. Christie* tested about 100 long columns, mainly angles and T-sections, with ends flat or fixed. A few of them carried loads greater than $3\,P_Y$; a certain number failed at about $3\,P_Y$, notably the long columns with ends fixed, and the remainder at smaller loadings. Results of tests at Watertown Arsenal in 1882 on I-section columns with ends flat are given in the accompanying table, $3{\cdot}2\,P_Y$ being the approximate capacity of the long columns. Long timber columns tested with ends flat at Watertown Arsenal in 1880 (Lanza, *loc. cit.*, page 659) failed at an average of $4\,P_Y$. There is not a great deal of published data on recent tests of columns with restrained ends and it has been assumed that, as all long columns deflect before they buckle, the methods of testing must be imperfect, but the provisions of the Codes of Practice, referred to by Mr. Leivers, appear to indicate that engineers are not certain that this has always been the case. $2\,P_Y$ for columns with fully restrained ends is an adequate safeguard against imperfections and, as there is also a substantial factor of safety added, the effective length might possibly be decreased under suitable conditions.

* First Report, Steel Structures Research Committee, D.S.I.R., page 211, H.M.S.O. (1931).

The limit of flexibility is the point at which appreciable lateral deflection of a straight axially loaded column does not occur before the column buckles. The work done by the applied load provides the energy required to produce the axial and the transverse strains, the balance of available energy being the strain energy of deflection and transverse shear. Using the elementary principles of mechanics, it can be shown that the transverse strain energy of a long test piece is equal to the axial strain energy and that it is a function of the elastic modulii, but it is found from crushing tests that the thickness of the material, the profile of the cross-section and, probably, other elastic properties are factors that have to be taken into account. This is confirmed by the normal results of tension, impact and bending tests, and further relevent information may be obtained from photoelastic, ultrasonic and other methods of research. When there is insufficient work done by the axial load to cause the column to deflect before failure, it is no longer flexible, so that the Euler analysis, based on the theory of deflection, evidently could not be directly applicable. The limit of flexibility sometimes coincides approximately with the yield point of the material or the proportional limit, but for cast-iron test pieces it appears to occur usually at a greater axial stress. The interesting diagram of Mr. Leiver's letter shows that the limit of proportion and the Euler limit do not coincide exactly for small timber struts, and the discrepancy is much greater when the ends are restrained. The yield point of the 3 in. × 3 in. × ¼ in. angles used by Strang and Strickenberg in the tests illustrated in Fig. 3 of my article (ENGINEERING page 656) was 36,710 lb. per sq. in., but the limit of flexibility appears to be about 24,500. The yield point in compression of the wrought iron used by J. Christie was about 30,000 lb. per sq. in. (Ref. *Trans. Amer. Soc. C.E.*, vol. 13, page 263 (1884)) and the limit of flexibility appears to be about 25,000 lb. per sq. in. Similar results are normally observed for other materials of practical thickness. The effect of the thickness on the axial strength of mild-steel structural members is referred to in Appendices A and B of B.S.S. 449 (1948), but in materials with a larger Poisson's ratio, e.g., timber and light alloys, the effect is more pronounced.

Thanks are due to Mr. Leivers and to you, Sir, for drawing attention to printing errors in the mathematics on page 657.

Yours faithfully,

A. N. PROCTER.

528 Beechdale-road,
Nottingham.
December 8, 1956.

Tests on Wrought-Iron I-Bars in Compression at Watertown Arsenal (1882).
(Ref. G. Lanza, *Applied Mechanics*, page 429 (1906))
All bars tested with ends flat. E (assumed) 29×10^6 lb. per sq. in.

Length, in.	Size ($d \times b$), in.	Web thickness, in.	Area of section, sq. in.	Radius of gyration, in.	$\frac{l}{k}$	Load per unit area at failure, lb. per sq. in.	
						Test	$3\pi^2 E \left(\frac{k}{l}\right)^2$
57	9·0 × 5·45	0·64	14·4	1·22	47	37,850	—
155	10·52 × 4·4	0·4	10·26	0·98	158	20,170	(34,200)
192	9·08 × 3·56	0·4	6·85	0·72	266	12,460	12,550
192	9·09 × 3·59	0·43	7·15	0·71	270	11,916	11,750
180	6·96 × 3·6	0·42	6·05	0·75	240	13,990	14,480
192	7·94 × 3·58	0·45	6·65	0·71	270	12,540	11,750
193	7·98 × 3·6	0·44	6·59	0·72	268	14,010	11,900
216	10·52 × 4·28	0·4	9·3	0·92	235	16,020	15,500
264	10·53 × 4·49	0·48	10·19	0·93	284	11,100	10,650
264	10·51 × 4·43	0·50	10·46	0·89	296	10,310	9,780
264	15·51 × 4·90	0·53	14·8	0·97	273	12,400	11,500
266	14·74 × 4·84	0·53	14·74	0·96	276	12,690	11,250

Radius of gyration estimated from $I_Y = \frac{dt^3}{12} + \frac{b^3}{6}\left\{\frac{A - dt}{2b - 2{\cdot}2t} - \frac{b - t}{45}\right\} = A\,k^2$ where t is web thickness and A is area of section.

★ ★ ★

SHEAR DEFLECTION IN BEAMS

SIR, In a letter in your issue of November 23 (page 644) Dr. R. P. N. Jones dismisses my criticism of his article on shear deflection in beams as "quite trivial." This he does on the grounds that for a rectangular steel beam under a stress of 30,000 lb. per sq. in. there is only 0·3 per cent. change in certain coefficients. I presume that Dr. Jones is referring to the fact that in the case considered the coefficient α has the value 0·003. But when α is very small there is no need to consider the influence of P on the shear deflection. For example, a steel bar with an Euler buckling stress of 30,000 lb. per sq. in. would have this reduced by only 90 lb. per sq. in. if shear deformation is considered. Is it, therefore, surprising that when the whole correction for shear is trivial an error in the correction itself appears even more so?

The buckling load obtained from Dr. Jones' theory for a strut with hinged ends is

$$P_{cr} = \tfrac{1}{2}\left[\sqrt{P_S^2 + 4\,P_S\,P_E} - P_S\right]. \quad \text{(A)}$$

where P_E is the Euler load and $P_S = \frac{AG}{\lambda}$ which is the buckling load regarding the beam as of infinite flexural stiffness. If Dr. Jones had checked his formula against Timoshenko's (equation 181 in the second reference quoted in his article) he would have noticed that they do not agree. Timoshenko's equation is most easily remembered in the form,

$$\frac{1}{P_{cr}} = \frac{1}{P_E} + \frac{1}{P_S} \quad . \quad . \quad \text{(B)}$$

This formula was established by Engesser[1] in 1891.

Now when P_S is very large compared with P_E it is obvious that P_{cr} is very little less than P_E and equations A and B give practically identical results. This will be so for compact solid sections. For beams with thin webs, P_S can be of the order $10P_E$. P_{cr} is then about 90 per cent. of P_E and it is necessary to consider the shear contribution. For this case, equation A is about 0·8 per cent. in error.

When P_S is of the same order as P_E the error in equation A becomes serious. This will be illustrated by an example of sandwich construction taken from page 192 of *The Analysis of Structures*, by Professor Hoff[2]. The dimensions and elastic properties are

width = 1 in., thickness of core = 1 in.
thickness of faces = 0·032 in.
Young's modulus of the faces = $10{\cdot}5 \times 10^6$ lb. per sq. in.
shear modulus of core = 4,000 lb. per sq. in.

In the table on the next page are given the critical loads calculated by four methods. The last method is that given by Professor Hoff[2] and its accuracy has been verified experimentally.

It appears that equation B is as accurate as the more complex method of Professor Hoff. Only for cores of extreme weakness would this not be so. There is no doubt about the inadequacy of equation A.

Length of beam	10 in.	20 in.	30 in.
Euler load, lb.	17,630	4,405	1,960
Equation A, lb.	6,625	2,650	1,440
Equation B, lb.	3,260	2,095	1,320
Professor Hoff, lb. ..	3,260	2,095	1,320
Percentage of error of equation A	103	26·5	9·1

I do not understand Dr. Jones' last paragraph. If the function $p(x)$ takes different forms over various sections of the beam it would in any case be necessary to consider the boundary conditions at the ends of each section. My end conditions are described as cumbersome. Surely they are either right or wrong—whether they are cumbersome or not is irrelevant unless they can be simplified.

Yours faithfully,
P. C. DUNNE.

24, Pierrefondes-avenue,
Farnborough,
Hants.
December 1, 1956.

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[1] F. Engesser, "Die Knickfestigkeit gerader Stäbe," *Zentralblatt der Bauverwaltung*, vol. 11, No. 49, p. 483, Dec. 1891.
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COST OF LABOUR TURNOVER

SIR, I have read the letter, on page 677 of your issue of November 30, from Mr. Prince of Ronald Trist and Company, Limited. Unfortunately, the investigations carried out by the British Institute of Management do not confirm that the facts regarding the cost of labour turnover are well known to managements generally.

With regard to the remedy for high labour turnover, I am sure Mr. Prince will realise that almost every situation requires different treatment. In general, however, I feel that the problem should be approached under the following headings:

(1) Diagnosis of the reasons why employees leave the firm.
(2) Careful selection of new employees, including the use of tests where appropriate.
(3) Sound induction procedures to get new employees introduced to the firm.
(4) Effective training programmes for all employees.
(5) A sound personnel policy providing for the proper treatment of all employees, particularly with reference to wages and working conditions.

I dealt with some of these suggestions in the full text of my paper and I shall have the pleasure of sending Mr. Prince a reprint in due course. If any of your other readers would be interested in receiving a reprint, I should be glad to let them have one.

Yours faithfully,
R. L. WEBSTER,
Chief Personnel Manager.

Hoover Limited,
Perivale,
Greenford,
Middlesex.
December 4, 1956.

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COAL AS A RAW MATERIAL

SIR, Mr. G. W. J. Bradley in his letter on this subject (ENGINEERING, November 30, page 677), wonders whether I gave any thought to the economics involved before writing the letter published in your issue of November 16? May I assure him that I most certainly did.

Electric power cannot be generated at all without spending capital on power stations. The type of plant I suggested might have a higher capital cost than the plant required for a normal thermal power station of similar output, but the higher capital and maintenance charges would be offset by the free supply of heat. The time has now come—indeed, it had already arrived when the Avenue plant was being designed—when we must revise our ideas about the capital investment which is justified in the interests of fuel saving. We spent £51 million on atomic energy last year, mainly for this very purpose of reducing the pressure on our native fuel supplies.

It seems to me that Mr. Bradley is very wide of the mark when he suggests that it would be more rewarding to calculate the value of the heat and useful chemicals lost through combustion in inefficient household grates. These figures are well known. But if £100 million were spent on the installation of more efficient appliances in ten million homes, I doubt whether a pound of coal would be saved. If my own experience is any guide, ten million homes would merely be kept warmer in our miserable winter climate, using the same amount of fuel.

The wet quenching of coke is one of the larger holes in our leaky bucket of fuel. The fuel producer is in a position to plug this leak, and recent inquiries (such as that by Mr. A. E. Morris*) have shown that it might well pay him so to do. The increased capital and maintenance charges have not stopped the Ford Motor Company, Limited, from installing an efficient coke-cooling plant at Dagenham; and American private enterprise does not invest capital in such equipment without first seeing that it will pay for itself.

Perhaps all that is required here is a little co-operation between those deadly rivals, Mr. Therm and Mr. K. W. Hour.

Yours faithfully,
S. B. BAILEY.

London, S.W.1.
December 4, 1956.

* A. E. Morris, "Consideration and Assessment of Coke Dry Cooling." Read at the 93rd Annual General Meeting of the Institution of Gas Engineers, May, 1956.

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Obituary

MR. R. W. DANA, O.B.E.
Former Secretary, I.N.A.

It is with regret that we record the death of Mr. Robert Washington Dana, which occurred at his home at Cockmoyle, Rock, near Wadebridge, Cornwall, on December 3, at the age of 88. He was the son of the late Mr. William P. W. Dana, the marine painter, formerly of Boston, U.S.A., and was born in 1868. He received his education in Paris and at Clifton College, afterwards going up to Pembroke College, Cambridge, where he graduated with honours in mathematics and was subsequently made an M.A. Destined for a civil-engineering career, Mr. Dana became an articled pupil of Sir John Wolfe Barry, K.C.B., F.R.S., and Mr. H. M. Brunel and, after completing his apprenticeship, remained with them as an assistant. Mr. Dana gained experience in marine-harbour work during the construction of Barry Docks, bridge work on the erection of the Tower Bridge, and railway work as resident engineer of the Ealing and South Harrow Railway and other lines. He also acted as resident engineer on the reconstruction of Kew Bridge. He was elected an associate member of the Institution of Civil Engineers in 1895 and was transferred to the class of member in 1905.

In 1901, Mr. Dana became the secretary of the Institution of Naval Architects and editor of the *Transactions* of the Institution. He continued in this capacity until his retirement in 1935. For his work during the war of 1914-18 in the artillery-supply section of the Ministry of Munitions and, later, on the staff of the Director of Naval Construction, Admiralty, he was made an O.B.E. He was also awarded the Order of the Crown of Belgium and, in 1929, the Cross of Chevalier of the Legion of Honour. He had been an honorary freeman of the Worshipful Company of Shipwrights for a number of years.

Weekly Survey

Cover Picture: *To unload the ship-borne iron ore required for the blast furnaces at the Margam Works in South Wales, there are five transporter unloaders using grabs to remove the ore from the ships' holds. The stockyard alongside the wharf will accommodate from* 300,000 *to* 500,000 *tons of ore.*

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Increased Railway Traffic

The decision to suspend the call-up of key railwaymen as from December 14 is expected to allow the British Transport Commission to retain about 2,000 foot-plate staff, yard shunters, signalmen, permanent-way maintenance staff and signals and telecommunications maintenance staff at the next call-up. This is stated to represent about one-fifth of the labour shortage in these categories. During the past year there has been a very considerable improvement in the employment position on the railways and, according to the Treasury *Bulletin for Industry*, the total rise in employment between October, 1955, and last October was 9,000. This has put the railways in a very much stronger position to meet the increased traffic likely to arise from the shortage of petrol and Diesel oil than would have been the case 12 months go.

It has, in fact, been reported that men who have lost their jobs in the motor industry have had difficulty in finding vacancies on the railways, and that with the present level of traffic there is no longer an acute labour shortage, though in certain parts of the country serious local shortages still exist.

It was estimated at the end of November that a 20 per cent. increase in rail freight tonnage could be achieved simply by filling up existing wagons; spare capacity on a number of feeder services to freight terminals was even greater. Since 1950 the total wagon-carrying capacity of the railways has risen by about 10 per cent., yet total tonnage carried has fallen slightly. Carrying capacity has also been increased because of the rise in the number of trains fitted with continuous vacuum braking which enables speeds to be approximately doubled. There was an increase of 7 per cent. between 1955 and 1956 in the number of trains fitted with continuous braking. If necessary, a further increase in carrying capacity can undoubtedly be achieved through more rapid loading and unloading of wagons, for example, by working at weekends. It has been estimated that about 25 per cent. of total time taken on freight journeys is taken in standing in terminals, and in loading and unloading.

Supplies of large coal for locomotives may possibly prove a limiting factor to the expansion of carrying capacity. During the current year some 60 per cent. of total imports of coal have consisted of large coal and the possibilities of expanding production in this country are not good. Much will depend also on the weather, since both passenger and freight traffic are normally at a maximum in winter and prolonged snow and hard weather may prevent the fulfilment of normal schedules, without allowing for the increased traffic that is to be expected this year.

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The Trend of Prices

The increased duty on petroleum products was presumably imposed with the double object of preventing an increase in purchasing power, and hence inflationary pressure on the economy generally, due to an enforced reduction in expenditure on petrol, and to help in preventing the development of a black market in petroleum.

Although it has been stated that the increase is only temporary the rise in road freights and in fares must have a strong influence on the attitude of unions engaged in wage negotiations, which at present concern over six million workers. If the increase in road freight charges can be held at about the figure of 10 per cent. which has been fixed by the National Conference of Road Transport Clearing Houses, this may not represent a very large addition to industrial costs, especially if an appreciable proportion of the freight at present carried by road is diverted to the railways.

Additions to industrial costs must, however, also result from the 60 per cent. increase in tramp shipping freights which has occurred since the Suez Canal was put out of action. This increase is due primarily to the shortage of shipping rather than to increased costs; even without the Suez crisis some increase in freights was expected this autumn since the effective world dry-cargo fleet has been growing more slowly than the total volume of world trade. The release of requisitioned vessels and of Liberty ships from the United States "mothball" fleet has so far had very little effect on rates. The effect of increased freight rates on prices though relatively small on average, may be considerable in the case of certain commodities such as grain and iron ore, and of coal if it becomes necessary to import it on a large scale.

Base-metal prices, always sensitive to the threat of war, have already shown a rise which was substantial in the case of tin but less marked for lead and zinc and least of all for copper. It seems probable therefore that in the absence of any further intensification of international tension, base-metal prices may decline in the immediate future, particularly since consumer demand is likely to be reduced. An exception, of course, is provided by nickel where the recent rise of £81 per ton follows a period of price stability since the autumn of 1954. The increase would appear to be justified by the continuing shortage of nickel and the fact that the International Nickel Company of Canada are faced with financing a 175 million dols. expansion scheme.

Prices of tea, sugar and wool, already directly affected by the closing of the Canal, are unlikely to show much reaction in the immediate future. In the longer term, the effect of the crisis on the level of prices generally is likely to depend mainly on how far it is possible to resist a general wage increase, the effect of which would remain long after the Canal is re-opened.

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Bristol's Good Week

Three new orders for Britannias last week brought the total number ordered to 65, while options have been taken on nine more. The value of the order book was thus brought to over £65 million. The most important of these orders was the final confirmation, some two months after the first premature announcement in the British Press, of the contract for five Britannia 305 aircraft for the United States Northeast Airlines. The prototype of this airliner flew for the first time in July this year. To enable Bristol to meet the required delivery date in the autumn of 1957, B.O.A.C. has agreed to release five of the aircraft which it had on order.

The two other orders are for three further aircraft for R.A.F. Transport Command worth over £3 million, and for two series 310 long-range aircraft for Hunting-Clan. The firm orders for Britannias are thus at last approaching the break-even figure of around 80 aircraft.

At the same time it is announced that a decision is likely to be taken soon to clear the Britannia for passenger service with B.O.A.C. This may mean that Britannias will be introduced within the next two months. The Britannia will therefore finally be in service some 4½ years after the first flight of the prototype in August, 1952.

It thus seems as if the Britannia may finally triumph over the technical delays which have held back its introduction for about two years. In spite of all that technical skill can do, the success of a civil aircraft is still to some extent a matter of luck and timing. The problems facing airline operators in deciding to order a particular aircraft are immense. The operator must be sure that in purchasing a particular aircraft he has equipment which will not only be superior to that of his competitors on its first introduction, but will remain competitive over a period of several years. In face of the fact that American propeller turbine aircraft are promised as early as August, 1958, the decision of Northeast Airlines to purchase Britannias must be regarded as a great act of faith in the Britannia. As one airline representative is reported to have said during the recent tour of the North American continent by the Britannia, "This is a sweet ship and maybe we'll buy it, but it seems to me it might be like buying a cream elephant due to turn white in a year."

However, British aircraft manufacturers now have a further foothold in the American domestic airline market, and in spite of the disappointment and delays in the development of the Britannia, it is worth while remembering that at one stage the all-conquering Viscount was nearly dropped. Though conditions are now very different from those obtaining a few years ago, an existing aircraft may yet prove more attractive to some operators than American "paper jets," in spite of the prestige enjoyed by their designers.

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Commonwealth Trade

The review of Commonwealth trade in 1955-56 published last week by the Commonwealth Economic Committee is of particular interest in relation to the proposal for British association with a partial free trade area in Western Europe. In 1955-56, the United Kingdom was the largest market for almost every Commonwealth country and after remaining nearly level for the previous four years United Kingdom imports from the Commonwealth increased by about £150 million. United Kingdom imports from other sources, however, rose to an even greater extent and the share of total imports supplied by the Commonwealth, although still amounting to nearly one-half, showed a slight decline.

Western Europe also constitutes an important market for Commonwealth countries, who supplied rather over one-third of total imports in 1955-56. All Commonwealth countries except Australia showed increased exports to Western Europe. Although the trade balance of both India and South Africa with Europe deteriorated during the past year, most Colonial territories showed a substantial surplus in their trade with Western Europe.

Mr. Macmillan stated in the House of Commons at the end of November that about 90 per cent. of present United Kingdom imports from the Commonwealth, comprising food and raw materials, would not be affected by British association with a common European market. The range of Commonwealth manufactured products on which preference in the United Kingdom would be lost was quite small in relation to these imports of food and raw materials and the country most likely to be affected would be Canada. It has, however, been suggested that in the long run the main effect of closer association between the United Kingdom and Western Europe may well be to provide an increased trade impetus for industrial exporters in the Commonwealth compared with primary producers.

It is probable that, as a closer association develops, opportunities may arise for increased European investment in the Commonwealth. Sir Albert Braithwaite drew attention in the House of Commons at the beginning of this month to the need for more rapid development of Commonwealth countries, mentioning in particular the large reserves of coal in Tanganyika and Rhodesia and the recent discovery of oil in Nigeria. It is difficult to see how the United Kingdom alone can provide greatly increased funds for investment in the Commonwealth, but, as a balancing factor to American capital provided through the World Bank and the Import-Export Bank, it might well be possible to set up a joint development authority in which the United Kingdom, the Commonwealth and Western European countries are associated.

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Civil Engineering in Canada

Towards the end of November two important contracts were awarded to Canadian subsidiaries of United Kingdom building and civil engineering contractors. The first of these, as noted the week before last, and valued at 7·2 million dols., was secured by Russell Construction of Toronto, a subsidiary of Balfour Beatty, from the St. Lawrence Sea Way Authority for dredging the Welland ship canal. The second, valued at 9 million dols. was awarded by the Canadian Government to Anglin Norcross, a subsidiary of Holland and Hannen and Cubitts for a new federal income tax headquarters at Montreal.

Canada has always been a difficult market for British civil engineering contractors but the latter have achieved a large measure of success during the last 18 months. The total value of dollar contracts won increased from £6·8 million in the year ending March, 1955, to £22·6 million in the year ending March, 1956, while the estimated value of work done rose from £2·7 million to £19 million and the value of work outstanding at the end of the year from £4·7 million to £15·7 million.

Total building and civil engineering work in Canada has been running at a very high level over the last few years. The value of contracts let in 1955 reached 3,183 million dols. of which 1,216 million dols. comprised residential contracts, 761 million dols. commercial and institutional, 386 million dols. industrial, and 820 million dols. engineering. Competition from local and United States companies is very severe, particularly on the building side.

Other important contracts secured by United Kingdom contractors during the past year include work at Kitimat valued at about 5 million dols. by the Commercial Construction Company and the contract, valued at 6 million dols., for the head-office building for the British Columbia Electric Company in Vancouver secured by John Laing and Son. It would seem that, after a rather uncertain start, a number of British companies are now becoming firmly established in Canada and since the total value of contracts let during 1956 is expected to be a good deal higher than in the previous year there should be good prospects for continued expansion.

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Prosperity in Civil Engineering

Seven annual reports of civil engineering contractors and two reports of their suppliers suggest that the past year's trading has been highly successful, with increased turnover and profits in most cases. The shortage of steel has tended to hold back progress in many contracts and, for most companies, has acted as a disrupting influence on schedules. A shortage of skilled labour has also operated against quick progress. There is a great deal of confidence in the industry and order books tend to be very full, despite the Government's reluctance to embark on a major road-construction programme and despite credit restrictions. The latter have led to an increase in competition in the industry and rising costs have tended to cut down profit margins. On the whole, however, the industry appears to entertain high hopes for the future.

The chairman of the Cementation Company, Mr. A. R. Neelands, gives a very full review of

their activities, at home and overseas. There was disappointment at the failure of the tender for the Kariba Gorge scheme hydro-electric project, submitted jointly with John Laing and Son, Limited, which was awarded to the Italian group "Impresit." Nevertheless, there is considerable activity in specialist cementation work at home, in increasingly competitive conditions. The company's shaft sinking and underground development in coal mines continues to expand in accordance with the programme of the National Coal Board. Their subsidiary, John Thom Limited, have been very active in drilling operations and expect another busy year despite the near-completion of the National Coal Board's drilling programme. The group's trading profits, at £680,665, were nearly 8 per cent. higher than the previous year. Crowley, Russell and Company, Limited, Hawkins Brothers Holdings (Gosport), Limited, the Oxley Engineering Company, Limited, Sir Lindsay Parkinson and Company, Limited, and Roads Re-construction (1934), Limited, all report very satisfactory order positions and excellent results. The latter report the fact that no major road schemes will be started in the immediate future, but nonetheless expect to show improved results during the current year. Sir Lindsay Parkinson report that "success in securing a wide variety of building and civil engineering contracts" is continuing and their open-cast coal activities expanding. Crossley Russell and Hawkins Brothers both mention rising costs, which are affecting the whole industry and reducing profit margins.

So far, therefore, it would seem that there will be no shortage of work in the industry. But the shortage of steel, and the high cost and scarcity of skilled labour, may grow worse during 1957.

* * *

A Calder Every Week

Current anxiety concerning the security of imported oil supplies and the effect on British industry of a prolonged shortage has led to a hasty re-assessment of our future needs and the means available for satisfying them. In particular, the electricity industry has been considering the possible extent of increased demands on its capacity. Two factors are of prime concern.

First, there is the plan for railway electrification and the decision to make interim use of increased Diesel services, not only for branch lines, where electrification would be uneconomic, but also for main-line traffic. Doubts are now being expressed as to the wisdom of such a move, particularly since there may be considerable inertia against making a further change once the Diesel locomotive is established. If the Diesel is abandoned, however, can the large-scale changeover to electric services be effected before the obsolescence of steam locomotives begins to take serious effect? And can the electricity industry cope with the increased demands of accelerated electrification? There are certainly those who think it can.

But there is also the second factor, and this must be seen in relation to the first, since both depend in general on the manufacturing capacity of the same firms. Shortage of fossil fuels—for indigenous coal resources offer little more comfort than supplies of oil—has also made necessary a considerable expansion in the United Kingdom atomic power programme, perhaps to more then double the installed capacity envisaged in the original White Paper. The oil shortage has underlined the urgency of this development. Atomic fuels cannot at present either directly or indirectly provide power for road transport—with the exception of trolleybuses; oil on the other hand is the only convenient mobile fuel and should be spared for that purpose. We should thus be prepared to replace at least existing oil-burning stations with nuclear plant. But can the electrical plant manufacturers meet both the nuclear requirement and that entailed by railway electrification?

There is some reason for confidence. Heavy industry installs in power stations each year steam generating plant corresponding to 2 million kW, and it has been suggested that this could well be doubled, provided that the anticipated increase in the number of technologists is in fact realised. Thus, on the basis of a doubled figure for generating plant output only, British firms are capable of producing an atomic power station like Calder Hall every week. This or its equivalent they may well be called upon to do.

* * *

This Uncertain World

The accounts of John Brockhouse and Company, Limited, for the financial year ended September 30 were published last week, only two months after the year's close. For a group as diversified as they are—they own 20 subsidiary companies in this country, 4 overseas and have 8 branch factories—it is a remarkable performance and an example a good many less complicated concerns could follow with advantage. The Group have had a successful year, with trading profits (at £972,000) 15 per cent. above the previous year's. In his statement accompanying the accounts their chairman, Mr. John Brockhouse, emphasised the increasing difficulty of forecasting the future: "No business man can foresee how tomorrow's news will affect his plans. It may be an international event, such as we are facing now, and the threat of a shortage of oil, or the sudden imposition of restriction by a domestic government, not necessarily our own, which causes a complete reversal of trends in the market." Mentioning a slight falling off in the order book during the past six months, which he does not anticipate will lead to a serious fall in output, Mr. Brockhouse reluctantly concludes it is impossible to say what the position of the engineering industries will be during the second half of 1957: "I think much depends on the outcome of the near-East crisis, and the position of the oil supply. If this is satisfactorily solved, without too much delay, we might find a big expansion in the trade (engineering), but if it drags on, the repercussions cannot help but be serious for the whole economy of this country."

The sudden reversal of trends due to international events is also to be seen in the statement of Mr. W. C. Sproson, chairman of the Wolverhampton Die Casting Company, Limited. At the time of writing, probably during the first half of November, Mr. Sproson saw grounds for "cautious optimism" in respect of the company's sales to the motor and other consumer goods industries which constitute a large outlet for die castings. Since then the severe set-backs of the motor industry due to the fuel crisis will doubtless have radically altered the situation. The relatively low cost of die castings, however, may lead to their being accepted much more widely in a period of rising costs and this will probably offset the fall in the activity of motor vehicle manufacturers.

Two other companies, the Birmingham Small Arms Company, Limited, and Robert Hudson Limited (manufacturers of light railway material) show in their annual reports their consciousness of the uncertainty of conditions in the immediate future. Mr. J. T. Sangster, chairman of B.S.A., reports a fall in the Group's profits of over £1·2 million to £1·6 million and tells of various steps which are being taken "to strengthen the management of the Group." Much of the fall in profits is due to heavy losses incurred by the motor-car subsidiaries. Mr. Kenneth Hudson, chairman of Robert Hudson, reports increased profits, a much larger order book and anticipates good results during the current year provided "adequate supplies of steel and labour are available." Expansion overseas "due to prevailing unsettled conditions in this country," is now this board's policy. It will be interesting to see how many more companies come to the same conclusion during the next few months.

* * *

Electricity's Role in Farm Production

With agriculture becoming increasingly industrialised, on most modern farms the animals are considered as food-producing machinery to be operated under conditions conducive to maximum sustained output. Some of the ways in which the electrical engineer may be able to assist the farmer in optimising his production methods have recently been under discussion at a two-day conference on "Future Research on Applications of Electricity to Increase Food Production," organised by the Electrical Research Association and attended by representatives of all the interested parties.

Mechanisation is probably most advanced in the field of egg production, and one of the suggestions made at the conference was that laying hens should work three eight-hour shifts. Each group of birds would in turn spend eight hours in daylight, or ordinary artificial light, and 16 hours in darkness—which would, however, be punctuated by short bursts of high-intensity illumination, the effect of which is to shorten the egg-laying cycle time possibly by as much as eight hours. Cattle, too, are known to respond to light stimulation, but more information is wanted on how it can be used to increase their combustion efficiency and to control their breeding time.

In the United Kingdom every year some 40 million unwanted cockerel chicks have their necks wrung as soon as they have hatched out in the incubator. To eliminate this waste, poultry farmers, and stockbreeders also, would like at least to be able to ascertain, and at best to pre-select, the sex of the embryo chick. There are, apparently, possibilities of doing this by controlling the *p*H values of the blood of parent stock, and electrical instruments are required for monitoring the blood acidity. Another suggestion was that electrical methods of separating sperms carrying male chromosomes from those carrying female chromosomes might be devised.

Crop-growing and horticulture were also discussed at the conference, and in the latter field it appears that more effective control of lighting and of heating—particularly in relation to the utilisation of power-station waste heat—are required. One speaker thought that the most urgent need is for the development of growth rooms and experimental glasshouses with a high degree of control, from which it could be learnt how best to apply electricity to the economics of large-scale crop production.

Dealing with the agricultural power requirements in the Commonwealth, detailed local surveys of power potential, including mineral, hydro-electric, biological and solar resources, were called for. Prime needs are researches directed to lowering the cost of power distribution to isolated communities and farms, and to acquiring more knowledge of water management and the means for automatically controlling water table and artificial precipitation. Other fields for exploitation include the development of electric fencings for protection against wild game, electronic methods for product-sorting, portable power tools and electric winches for handling farm implements on land inaccessible to tractors.

Other subjects discussed were the possibility of high power/weight ratio electric batteries for mobile field power, or alternatively further development of a tractor-mounted electrical generator already initiated by the Association. The electromagnetic treatment of plants, pests and fungi were said to require more investigation; and for farm management, radio-telephone communications and instruments for measuring the quantity, quality, moisture content and rate of growth of crops, and the "workability" of soil were listed as desirable developments.

A switch of the tanker fleets of the western hemisphere to the ferrying of oil to Britain and western Europe is about to take place, on an unprecedented scale. The newest super-tanker of the Niarchos Group, the Evgenia Niarchos (47,120 *tons dead weight*), *photographed above during her trials, was delivered to her owners last Tuesday by Vickers-Armstrongs to proceed immediately on her first voyage on charter to Shell to bring oil to Europe.* Her sister-ship, the Spyros Niarchos, was the first tanker to arrive in western Europe since the blocking of the Suez Canal. She covered the 11,373 miles from the Persian Gulf to Berre, near Marseilles, in under 28 days at an average speed of 17·34 knots, compared to just over 12½ days at 15·68 knots to cover the shorter route of 4,722 miles through the canal before it was blocked. She was able to utilise her full capacity on the round-the-Cape voyage—nearly 4,000 tons more than was possible through the canal. Mr. Stavros Niarchos announced that the Group's two new tankers built in Japan—the 41,697 ton World Integrity delivered last week, and the 41,000 ton World Industry which will be handed over next week—will also be placed on western European operations.

Already 35 of the 44 tankers owned by the Group are on European service, with an aggregate carrying capacity of 880,000 tons, or 264 million gallons of fuel. Under the United States Administration's programme, the Middle East Emergency Committee will have a large fleet of tankers diverted to European service. The largest will use the route round the Cape and the others will carry oil from the Gulf of Mexico. United States officials now believe that these tankers and those under European ownership will be able to move about 800,000 barrels of oil a day when the programme is in full swing. This compares with an estimate of 500,000 barrels made the previous week. It is now possible that the present level of 300,000 barrels a day imported from the Gulf and Caribbean areas will be trebled and that shipments from the Middle East round the Cape will bring total supplies to within 90 per cent. of normal requirements, if they can be afforded.

The Short-Term Outlook

The immediate future is viewed with grave misgivings for two main reasons. First, despite the rescue operations described above, the supply position is likely to get worse during the next three to five weeks, particularly for fuel and gas oils. Severe dislocation of industry may prove unavoidable. The second is concerned with rising prices and falling reserves of dollars. The

OIL'S TEMPORARY ECLIPSE

Government have clearly been caught unprepared, as the nature of the steps they have taken so far has shown. The rationing of petrol and the heavy increase in duty are aimed to reduce the import requirements rather than make available supplies go round. The 10 per cent. cut in oil supplies to industry will almost certainly not be sufficient and further cuts are expected later this month. The fall of 279 million dollars in the country's gold reserves during November, with worse to come this month, will prejudice any hope of maintaining the cut at that level, even if, as is likely, the Government's request for a waiver on interest repayments of the United States and Canadian loans is granted. Sterling is in danger, and further measures to reduce the dollar drain will doubtless be taken. Application has been made to the International Monetary Fund to draw a large sum of dollars to meet the crisis. Some relief will doubtless be obtained—565 million dollars has been mentioned—but the situation will remain critical. It could well be that the Government will decide to take less oil than could be obtained from dollar sources.

Viewed in this light, the many protests and warnings made by a number of bodies, including the Federation of British Industries, Society of Motor Manufacturers and Traders, National Union of Mineworkers, Road Haulage Association, British Road Federation, Trades Union Congress and others, can have little impact. Inevitably, costs and prices will rise in most sectors of the economy. The estimated cost to industry of the recent increases in petrol and oil prices will amount to some £65 million a year, which cannot but be passed on to the consumer. In the season of wage demands this is dangerous indeed. It is inflation, rather than the physical shortage of petroleum products, which is the painful consequence of the Suez crisis.

Self-Help by Industry

A number of recent statements suggest that industry will do all that is possible to fight through the crisis by exercising the strictest economy and by pooling resources. Much saving is expected to arise from the use of "C" licence vehicles to carry goods in addition to those of their owners. The Government have asked the licensing authorities for goods vehicles "to consider sympathetically" the issue of short-term "B" licences which would enable "C" licence vehicles to be pooled between groups of firms so that full loads are carried both ways. The Ministry of Transport are most unlikely to consider the issue of supplementary rations for "C" licence vehicles of one ton unladen weight or less. The Ministry's announcement last week shows the carriage of goods by rail is being encouraged.

How industrial users of oil will be able to help themselves or one another is less clear. Some of the more fortunate—or the more far-sighted—specified oil-burning systems that could be switched over to pulverised fuel in an emergency. Among them is the Central Electricity Authority. A more intensive round-the-clock use of gas or coke-fired furnaces through the pooling of resources by local manufacturers could perhaps prevent an acute shortage of furnace capacity. Unfortunately, the gas industry is one of the largest industrial users of gas oil, and may have to reduce output if further cuts are necessary.

The distressing feature of the oil-burning conversion programme—discussed in the following note—is that it is so inflexible. Users are now learning the hard way, and future installations are more than likely to take into account the political risk which must remain closely associated with Britain's oil supplies.

The Future

Before the crisis, there was a general expectation that petroleum fuels would play a vital part in sustaining the country's industrial expansion. In fact, no estimate, even the most conservative, suggested that we could do without very large and rapidly increasing supplies of oil. The best documented forecast is probably that given by Dr. A. H. Daniel to the Institution of Production Engineers in the 1955 Viscount Nuffield paper, "Britain's Energy Prospects." Dr. Daniel concluded that to double the standard of living in a generation—Mr. Butler's forecast when Chancellor—oil supplies would have to increase from the equivalent of 38 million tons of coal in 1954 to 155 million tons in 1985. This took into account a contribution equivalent to 40 million tons of coal from nuclear power by 1975, rising to 94 million tons by 1985; and an increase in coal output from 230 million tons to a peak of 240 million tons in 1970.

Oil is the indispensable means to this country's future economic progress; even the most enthusiastic advocate of a bigger nuclear programme or the most fervent supporter of the coal industry would not question that statement. It follows, therefore, that Britain must secure her oil supplies. Now that force has failed, commercial means must be tried, for the alternative is to abandon our bid to raise our living standards. Last April, Shell-Mex and B.P. forecast an increase in oil consumption from 18½ million tons in 1955 to 34½ million tons in 1960, an annual average increase of 13 per cent. Within this total, distillate fuel oils, which can be used directly to replace coal, were expected to increase 23 per cent. a year. Of the extra 14 million tons of distillate expected to be available by 1960, six million were scheduled for consumption in power stations, 1½ million for the expansion of "orthodox uses," one million for the railways and six million for oil-fired boilers (a trebling of present consumption).

Already, people talk of speeding up the nuclear power programme, and of hydro-electric, tidal and solar energy. But the Middle East States wish to sell us their oil: they cannot live without. Political wisdom may pay better returns than a switch of plan at this stage—with the proviso that any new oil-burning plant might well be given the flexibility to use pulverised fuel so that we can weather another crisis without complete industrial collapse.

ENGINEERING CONTRACTS

11—POINTS ON ISSUING CERTIFICATES

By F. H. B. Layfield

This is the eleventh article of the series being contributed by Mr. Layfield for the guidance of engineers and others engaged on the preparation of engineering contracts. The tenth article appeared in ENGINEERING, *December* 7, 1956, *page* 713.

When a contractor carries out engineering works on a site it is normally a condition that the work in question must be approved before payment is made. If this approval is to be that of the employer himself difficulties may arise. When a contractor sells goods to another person and the purchaser does not like them, or does not approve of their quality, the remedy then is simple. The seller may recover the goods and resell them to someone else. But the contractor who has built works on a piece of land is not in that position.

As already pointed out, when materials are affixed to, or built into, the land they become part of the land and are the property of the landowner. Therefore, if the employer does not give his approval to engineering works which the contractor has executed, the contractor may find himself in a very serious and difficult position.

The contractor has spent a great deal of money and may be unable to recover anything for it. He cannot obtain payment under the contract because it has not been fulfilled; the employer's approval being withheld. He may find it difficult to plead successfully that there was an implied promise to pay, since the law does not recognise mere use and occupation as sufficient evidence that there has been acceptance of the work done. Lastly, the contractor cannot take back the work or resell it to another because it is no longer his property.

It is for these reasons that some system other than the approval of the employer is found to be desirable. Furthermore, most engineering contracts involve the expenditure by the contractor of very large sums of money. It is often neither convenient nor practicable for him to wait until the end of the contract for payment.

These difficulties have led to the adoption of the system, now in general use, whereby a third party certifies approval of the contract works stage by stage as they progress. This third party is the engineer and it is normally provided in most modern contracts that payments will be made by instalments when the engineer issues the appropriate certificates.

KINDS OF CERTIFICATES

The engineer may be expected in the course of the contract to issue three kinds of certificates. The one that the engineer is most often called upon to produce is that usually known as a progress certificate, against which a stipulated percentage of the value of the work done, and of materials used, will be paid. After the last of such certificates has been issued, there comes the final certificate, which signifies approval to the whole of the works.

The last kind of certificate which the engineer is normally expected to give is one certifying to a particular fact, or set of facts; thus, for example, such documents may indicate that tests have taken place satisfactorily, or that an extension of time has been granted to the contractor.

All these certificates have a number of requirements in common. None of them normally needs to be in writing, unless the contract explicitly requires that it should be. It is desirable, however, not only that the contract should require certificates to be in writing, but that the engineer should never depart from this practice. It may often be convenient to the engineer to give his approval to something orally, but, if this is not subsequently the subject of confirmation in writing, it is an event which will frequently be regretted later. Every certificate, of course, should be clear and explicit in its terms. The document should recite exactly what it purports to approve or the event which is said to have happened. It is also desirable that a certificate should be a separate document dealing with only one matter, and, in particular, a certificate should not be embodied in a letter or any similar communication.

Many difficulties can be avoided if a set form is used for these certificates, and such forms, or at least the most important of them, should be settled when the contract is signed. Certificates should always be dated and, while it is rare to find that a certificate has been issued which bears no date of issue, it is, unfortunately, not unusual to find certificates that do not indicate the dates of the events to which they relate. It cannot be taken for granted that the date of the certificate and of the event it records are necessarily the same.

ENGINEER'S IMPARTIALITY

The engineer may occupy a position of difficulty and delicacy when he is giving a certificate. His part in a contract was well described by Lord Justice Mathew, who, when referring to an engineering contract, in the case of *Cross v. Leeds Corporation*, said:

> "The engineer or architect under a contract of this sort is placed in two positions, and he is allowed to assume those two positions with the full knowledge of both contracting parties; and in the one position he is bound to do his best for his employer, and to look sharply after the builder while the work is going on, and it is his duty in that capacity to form an opinion as to what his employer is entitled to while the works are being executed. The contract, it seems to me, contemplates that differences are likely to arise between the builder and the architect or engineer, and that the time might come when the engineer should deal with them in a different capacity, and then he has to do his best as an honourable man to determine, judicially and finally, questions between the parties."

This statement of the law was approved in the House of Lords as recently as 1947. Yet, though the engineer may on occasion, when he is giving certain certificates, occupy this special and impartial capacity, that does not make him an arbitrator within the meaning of the Arbitration Act, 1950.

DUTIES WHEN ARBITER

When the engineer is occupying this special position between the employer and the contractor he may well ask himself what he may and may not do. Perhaps the most important aspect of this problem is the right of the engineer to consult with the employer.

Some useful guidance as to what the engineer may and may not do can be found in *Halliday v. Duke of Hamilton's Trustees*, in which Lord Justice-Clerk Macdonald said:

> "If, under a clause of reference, entered into by a contractor and his employers, it is agreed that the employers' engineer shall be the arbiter in any question as to the work done by or money due to the contractor, in such a case there cannot be such absolute abstention from communication between the employers and the party named as arbiter as in the case of a reference to an independent arbiter. In a case where the engineer is named as arbiter, and the contractor comes forward with a claim for a sum of money as being due to him, it is the most natural thing possible for the employers to inquire of their engineer what view he takes of the work done by the contractor and the account rendered by him, because if the engineers are satisfied that the claim is proper, there will not be any need for arbitration, and an engineer who expresses a general opinion, not ultroneously but in answer to his employers, cannot I think be excluded on that account from acting as arbiter."

The right which the engineer has, when acting in his impartial capacity, reasonably to consult his employers must not, however, be taken to mean that he must follow their wishes and instructions. This was made clear by Lord Esher, when he said of the engineer that:

> "His duty is to give the certificate according to his own conscience and according to what he conceives to be the right and truth as to the work done; and for that purpose he has no right to obey any order or suggestion by those people who are called his masters. For this purpose they are *not* his masters. He is to do that on his own conscience, wholly independent of them, and to act fairly and honestly as between them and the contractors."

DIVIDING THE WORK INTO STAGES

The most frequent kind of certificate with which the engineer is concerned is an "interim" or progress certificate. In this instance, the engineer can clearly be recognised as acting as the employers' agent and as having no special impartial capacity. The number and timing of progress certificates depends upon the manner in which the contract work has been arranged. Very often the tender will set out the several stages of the work, and this division of the work into stages, for the purpose of issuing the progress certificates, may be done in several ways. Sometimes, a minimum sum of money will be established below which no progress certificate is to be issued. Such a procedure may provide that certificates can be issued whenever, say, £20,000 worth of work has been completed.

Alternatively, the stages of the work may be divided according to the passing of time and it may be provided that certificates will be issued, say, once a month or once a quarter. It is also convenient, sometimes, to arrange a combination of these two methods, so that a certificate will be issued at stated periods, provided that a given value of work has been completed by that time. Any of these three arrangements may, in its turn, be dependent upon the satisfactory completion of tests of differing kinds. Where, however, a simple and straightforward yardstick is not to be employed, such as either time or value alone, then the engineer, when setting out the terms, whether in the tender or in any other document, should carefully consider the inter-relation of the differing tests which are prerequisite to the issue of a progress certificate.

The progress certificate must state certain specific facts if it is to be of real value. The engineer should tell the draftsman, when the contract is being prepared, what he wishes the draftsman to include in each certificate. One example of a clear set of requirements occurs in the "A" form of the Institutions of Mechanical, Electrical and Consulting Engineers. Clause 30 of that form provides, among other things, that:

> "Every interim certificate shall certify the total value of the work duly executed on the site and of the plant delivered to the site for use in the works pursuant to the contract up to the date named in the application for the certificate, less the said total value so certified in the last previous certificate (if any). . . ."

In cases where shipments of plant are involved, it is desirable that any certificate should clearly identify the actual plant concerned. Thus, in

the " B3 " form of the Institutions of Mechanical, Electrical and Consulting Engineers, it is provided that, when application is made for a certificate:

> " Each such application in respect of shipment shall identify the plant shipped, state the amount claimed, and be accompanied by such evidence of shipment and of payment of freight and insurance as the engineer may reasonably require."

What it is desirable to include in the certificate must depend upon the technical details of the work to a large extent and, therefore, it is for the engineer to instruct the draftsman accordingly.

WHEN CORRECTIONS ARE NEEDED

When contract works are going ahead and many different matters are occupying the mind of the engineer and his staff, the effect which the issue of certificates may have upon affairs can sometimes be very confusing. Accordingly, the engineer will be wise to see that certificates issued during the progress of the work do not prejudice the final position. This means that two stipulations should be included in the contract. In this connection, the "A" form states that " no interim certificate shall be relied on as conclusive evidence of any matter stated therein, nor effect or prejudice any right of the purchaser or the contractor against the other." The same form also goes on to grant a most necessary power to the effect that " the engineer may in any certificate give effect to any correction or modification that should properly be made in respect of any previous certificate."

The engineer's power to correct his certificates has one aspect of particular importance for him. It has already been mentioned that, when issuing progress certificates, the engineer is acting as the agent of the employers. It follows, therefore, that if he certifies as satisfactory work which subsequently proves to be defective he may be liable to an action for negligence.

In *Saunders and Collard v. Broadstairs L.B.*, for example, the superintending engineers were found to have been negligent because they had certified the completion of a drainage scheme and had over-certified the amount of work that had been done. The Court held that the engineers were liable to repay to their employers the amount by which the contractors had been overpaid on the certificate they had issued. It was also held that the engineers' liability was not limited to the amount of their professional charges.

APPLICATIONS FOR CERTIFICATES

Progress certificates may normally be obtained in one of two ways. In the first place, a contract may provide that the contractor is to apply for the certificate when he considers that it is due. This is the arrangement favoured in the "A" form, which arranges that:

> " Application for interim certificates may be made to the engineer from time to time during the progress of the works. Each such application shall state the amount claimed and shall set forth in detail . . . particulars of the works executed and of the plant delivered to the site to a date named in the application and since the period covered by the last preceding certificate, if any."

The alternative method is that favoured by the Institution of Civil Engineers' General Conditions which provide, instead, for the submission by the contractor to the engineer of a monthly account showing the value of work done and materials used. It is largely a question of administration which of these methods is found to be the more convenient. In either case, the engineer will normally be under a liability, placed on him by the contract, to issue a certificate within a given period of either the contractor's application or of the submission of the account.

Whichever method be adopted it is very undesirable to have the provision which the "A" form contains allowing the contractor to stop work if the certificate is not issued within a prescribed period. The better procedure, if the certificate is not issued, is to permit immediate recourse to be made, if necessary, to arbitration.

The progress certificate is largely a matter of authorising interim payments to be made and it is to be taken as *qualified* approval only of the quality and nature of the work to which it relates, unless the provisions of the contract state otherwise.

This means to say that the engineer is not prevented from questioning the quality of the work later on, and, also, that he is not prevented from refusing to certify that any part of the work is satisfactory. Nevertheless, it is desirable, as a matter of caution, to reserve the engineer's various rights in these respects explicitly in the contract.

ISSUING THE FINAL CERTIFICATE

The final certificate is very different in many respects from the progress certificate. The final certificate is normally to be taken as approval of the works and an indication that they have been completed to the satisfaction of the engineer. It is when he is considering the issue of this certificate that the engineer occupies the special impartial position already mentioned and, therefore, when dealing with the final certificate, the engineer should act accordingly. He will normally give the certificate on one of two dates. The first likely date is that when the maintenance period has been concluded. Thus the "A" form specifies that:

> " Application for the final certificate may be made to the engineer at any time after the contractor has ceased to be under any obligation under clause 29 (maintenance period). . . ."

On the other hand, the final certificate may, in effect, be given when the completion of the works, or a substantial completion of them, has taken place.

Because the final certificate is normally to be regarded as approval of the work, if it is issued before the maintenance period ends, then precautions must be taken to see that the certificate is not regarded as being the equivalent of final approval. So it is that the Institution of Civil Engineers' General Conditions include a reservation which states that:

> " The contract shall not be considered as completed until a maintenance certificate shall have been signed by the engineer and delivered to the employer stating that the work has been completed and maintained to his satisfaction."

Also, it is provided in the same conditions that:

> " No certificate other than the maintenance certificate . . .shall be deemed to constitute approval of any work or other matter in respect of which it is issued. . . ."

This is a somewhat cumbrous method of dealing with the final certificate and it is suggested the better arrangement is that the final certificate should normally be so called and should be issued only when the maintenance period is over. If this latter arrangement is not adopted a confusion of nomenclature occurs and many saving clauses are needed in order to make it clear that the general arrangements otherwise assumed to exist do not in fact apply. The final certificate may or may not be conclusive and final as to the satisfactory completion of the works; this will depend entirely upon the detailed wording of the contract.

All the same, it is desirable that the contract should state clearly whether or not the final certificate is to be regarded as conclusive evidence of satisfactory completion. In the " B3 " form of the Institutions of Mechanical Electrical and Consulting Engineers, this is done by stating that:

> " A final certificate shall save in the case of fraud or dishonesty relating to or affecting any matter dealt with in the certificate be conclusive evidence as to the sufficiency of the works and of the value thereof."

And a very similar condition, but more elaborate than the foregoing, is included in the "A" form.

It will be recalled that the engineer is acting in an impartial capacity when he gives his final certificate and it follows that he will not be liable to the employer for negligence in giving this certificate unless there has been dishonesty, fraud or collusion.

OTHER POINTS TO REMEMBER

In giving certificates other than progress or final certificates the engineer's role is varied. Sometimes, he may be acting as agent for the employer and, sometimes, he may be acting in his impartial capacity. The circumstances surrounding the issue of each certificate will decide. But it may well be that, whenever the engineer has to exercise his judgment in relation to the quality or value of work done or material supplied, he may be acting in his impartial capacity. All the general comments made earlier in regard to certificates apply to these cases.

The power of the engineer to issue certificates is not one which he may delegate unless the contract expressly authorises him to do so. This does not mean, however, that he may not have assistance when preparing material for a certificate, and he may, in fact, employ people such as quantity surveyors to help him do so. If there are formalities laid down in the contract relating to the issue of certificates these must, of course, be observed. In particular, no certificate must relate to, or include, any matters which are not the subject of the contract under which the certificate is given.

Even when there are several contracts being carried out on one site by the same contractor, and for the same employer, it will be wise for the engineer to keep the certificates relating to each of the contracts involved quite separate.

The engineer may often have some direct or indirect interest either in the contract, in its execution or in some matter relating to it. Provided these interests are known to the parties concerned they will not disqualify him from his right to issue certificates. It is only when they are not known that he will be disqualified.

SUMMARY

In the course of an engineering contract, the engineer is called upon to issue several kinds of certificates. One class of these relates to the recording of events, such as the successful completion of tests. The second group indicates the progress of the work, stage by stage. The last group deals with the satisfactory completion of the contract work. In all these cases a standard form of notice will help to avoid difficulties and to ensure that the certificate contains the desired details. Every certificate should be a separate document and be as clear and accurate as possible and should relate only to the contract with which it is concerned. When dealing with these certificates the engineer may occupy one of two positions. In most instances he is the employer's agent, with all the duties and responsibilities that that position implies. When, however, the engineer is holding the balance between the employer and the contractor, as is the case in connection with the issue of his final certificate, the engineer occupies a special position. On such occasions, he must be impartial and be guided only by considerations of honesty and fairness.

* * *

GAS AT WORK

With the object of demonstrating some of the numerous ways in which gas plays its part in industry, an exhibition, claimed to be the first of its kind to take place in London, is being held at the Royal Horticultural Hall, Westminster, London, S.W.1, from January 22 to February 2, 1957. Exhibits on show will range from gas-fired water and space heaters to highly complicated equipment for shell moulding, tool cutting and flame hardening: many of them electronically controlled.

SHOT BLASTING WITH TWO-STAGE SHOT PROJECTION

PRE-ACCELERATION IN IMPELLER UNIT

It is well known that there are several possible ways of projecting shot in a shot-blasting machine. The range of machines now being made by Baker Perkins, Limited, Westwood Works, Peterborough, is of the type which requires no external air supply, and makes use of a principle which has not hitherto been applied in this country, though it is widely used in France and some other European countries. The machines are being made under licence from S.A. Etablissements Sisson-Lehmann, Charleville, Ardennes, France, and incorporate their "ASL turbine" unit for shot projection.

SHOT ENTERS UNIT AT IMPELLER SPEED

The shot projection unit, which is shown in Fig. 1 in both "exploded" and assembled form, comprises a centrifugal impeller and a fan, mounted on the same shaft, and motor driven through V-belts. The impeller consists, essentially, of two flanges joined together by blade members, rotating in a steel housing. The blades, housing lining and other parts in contact with the shot are easily removable, and are made of a special white iron which is highly resistant to wear.

Air from the fan on the impeller shaft is piped to the opposite end of the unit, where it meets the shot, which falls by gravity from an overhead hopper, and drives it forward to the impeller. By the time it reaches the initial point of contact with the impeller blades, the speed and direction of the shot are such that there is virtually no shock of contact. The shot is then finally accelerated to its pre-determined discharge speed by the impeller, and projected from the unit. The design ensures that the major part of the work of accelerating the shot is done by the air from the fan, leaving the impeller to impart the final velocity and direction only. Consequently, the wear of the impeller blades is very small and evenly distributed. The impeller unit is designed to allow of shot projection in different directions according to requirements, and the unit is made in two forms, right-hand and left-hand. Both these forms are shown in Fig. 1, the assembled unit being the left-hand type. In addition, the unit is produced in a range of sizes, running at speeds from 3,800 to 14,000 r.p.m., and driven by electric motors from 3 to 20 h.p. The unit is therefore adaptable for use in various types of shot-blasting machine, and can give full shot coverage wherever required.

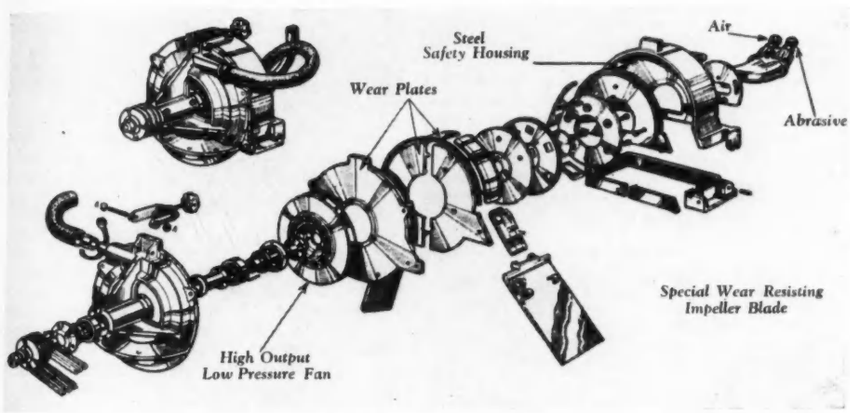

Fig. 1 The basis of the Baker Perkins shot-blasting machines is the shot-impeller, in which the shot is pre-accelerated before it makes contact with the impeller blades.

ROTARY TABLE MACHINE

One of the applications of the shot projection unit is to the rotary table machine illustrated in Fig. 2. One or two projection units may be used on a machine, according to size and other circumstances; two are fitted to the machine illustrated. The rotary table has about two-thirds of its surface housed in the totally-enclosed blasting chamber, and there is a series of rubber and nylon screens which permit entry and exit of components on the table, and prevent the escape of shot. The table is of fabricated mild steel, with white-iron perforated wearing plates on the surface. Scrapers working under the table sweep the shot and sand into a gravity feed hopper, from which a bucket elevator leads to a separator mounted above the hopper feeding the shot projection unit. Usable shot is separated automatically from scrap shot, sand and pieces of metal such as casting flashes and core nails. The shot is discharged into the hopper above the projection unit ready for re-use, while the scrap shot, sand and scrap metal are allowed to fall into separate containers, from which they can be removed as necessary. Dust and shot separation can be carried out while the projection unit is not running. One complete set of separator equipment is fitted to each projection unit; there are therefore two on the machine shown in Fig. 2.

The rotary table is driven through a worm reduction box and an infinitely-variable speed gear, the actual drive to the table being by means of a rubber-tyred wheel. A range of from 0·2 to 1·1 r.p.m. caters for different types of work. The inside of the table chamber is protected by special abrasion-resisting rubber sheets and white-iron plates, which are easily renewable. A baffle box and connection point for dust-extraction equipment are provided in the roof of the chamber. Access for maintenance purposes is through hinged doors, which are electrically interlocked with the machine drive for safety.

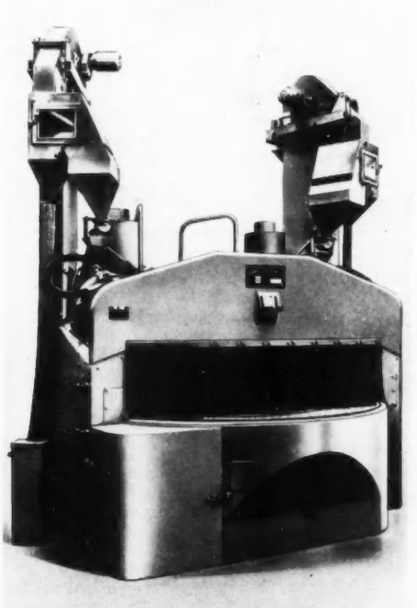

Fig. 2 One or more of the impeller units can be applied to machines of different types. Two units are shown here on a rotary table machine.

BARREL SHOT BLASTING

For small articles the barrel process is often ideal. Fig. 3 shows a barrel type machine which is included in the Baker Perkins range. This machine, as will be seen from the illustration, incorporates a single shot projection unit, which is mounted on the top of the totally-enclosed cabinet, and delivers shot downwards into the mouth of a slowly-rotating barrel containing the components to be shot blasted. The barrel is protected by renewable white-iron plates, and is perforated to allow the shot and dust to fall out. Internal baffle plates ensure that the articles in the barrel are continuously tumbled about, and all the surfaces are presented to the stream of shot.

The barrel is so mounted that it can have a rotary motion about its own axis while working and discharging, and a swivel movement in a vertical plane for loading and discharging. It is rotated by an electric motor through worm and bevel gearing, and tilted by means of a handwheel at the front of the machine. A motor-driven skip hoist at the back of the machine serves for charging, while the discharge is at the

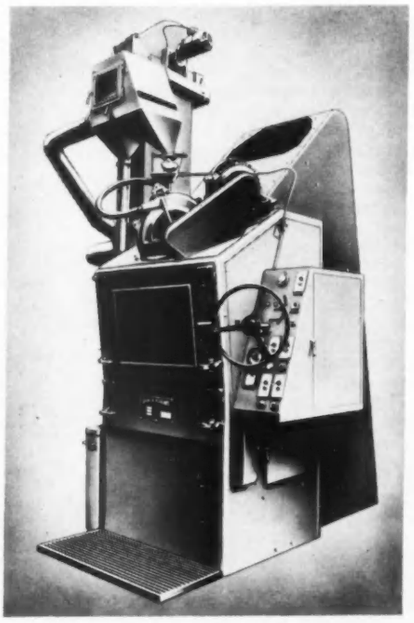

Fig. 3 This rotating barrel type of machine has a skiphoist for charging, a tilting barrel for discharging, and is controlled by an electric timer.

front of the machine. Equipment similar to that supplied with the rotary table machine is incorporated for the elevation and continuous separation of shot, sand and foreign matter.

In operation, a batch of components is loaded into the machine barrel by means of the skip, and the barrel is then lowered to its working position with its mouth in line with the flow of shot. The skip is detachable and on wheels, so that it can be taken to a convenient point for loading. Several skip bins can be kept in use if required. As soon as the barrel is charged and tilted down to its working position, the flow of shot is started. This is kept up while the barrel is rotated for a pre-determined period, an electric timer being provided on the machine control panel for stopping the machine at the end of this part of the cycle. When the shot blasting operation is over, and the flow of shot has stopped, the barrel is tilted downwards by means of the handwheel to discharge the contents into a container placed at the front of the machine. The barrel is then raised to its charging position, and the cycle re-commences.

With a barrel having a capacity of approximately 19·4 cub. ft., or up to 418 lb. of components, the machine operates on average cycle times of 4 to 6 minutes for cast iron, 6 to 10 minutes for malleable iron, and 12 to 20 minutes for steel castings.

FLAME-PROOFED TIMBER

There is an increasing demand for flame-proofed timber in the building, civil engineering, and mining industries. For instance, the National Coal Board are extensively employing timber impregnated with Pyrolith, a flame-retardant which also incorporates preservatives against fungus and vermin, in escape roadways in underground workings. Pyrolith is a product of Hickson's Timber Impregnation Company (G.B.), Limited, Castleford, Yorkshire, and timber treatment is carried out at 12 plants in Great Britain.

Pyrolith flame-retardant preservative is applied to timber by vacuum/pressure impregnation in the form of an aqueous solution. The liquid penetrates the whole of the sap-wood and an adequate amount of the heartwood. On re-drying, the water is lost to atmosphere and the Pyrolith salts are left deeply impregnated in the wood fibre and cell cavities of the timber.

When subjected to high temperatures the flame-retardant salts generate water and ammonia. The amount of water produced is greatly in excess of that normally present in timber and it helps to depress the rate of heat rise for a longer period. The water vapour and ammonia gas have the effect of diluting the naturally combustible gases generated, as well as diluting the oxygen in the surrounding air. Contact of the resulting mixture of gas with a spark or flame does not produce flaming of the timber and no general burning ensues. The point of contact between an applied flame and Pyrolith-treated wood glows red, but this glowing ceases immediately the flame is removed. High temperatures applied for a very long period result in the formation of charcoal, much harder and denser than that formed on untreated wood. This is beneficial because charcoal is an efficient insulating material and it also forms a barrier which keeps away the oxygen needed for combustion.

In the case of thin-section boards, such as ¼ in. plywood and ⅛ in. hardboard, the high surface-area to volume ratio affects the performance of Pyrolith treatment. Flaming may occur in the immediate vicinity of the applied flame, but its spread over the surface is greatly restricted as compared with untreated material.

Fires in buildings and ships build up step by step, first involving materials of low ignition temperature which then generate sufficient heat to set light to materials of a higher ignition temperature, and so on. The rate of this development depends upon the nature of the ignitable materials, their positions relative to one another, the oxygen supply and other factors. Pyrolith-treated timber contributes to safety: (1) by increasing the "ignition temperature," thus reducing the possibility of timber being involved in a fire; (2) by reducing the rate of spread of flame, thus limiting the extent of the fire in a given time and reducing the chances of other materials being involved; and (3) by charring without a significant temperature rise.

A large proportion of fires start at the back of panelling (this is particularly true of electrical fires) where surface coating can offer no protection. Pyrolith, on the other hand, is applied before installation. All surfaces are treated and a considerable depth of penetration is achieved. The treatment needs no renewal and it cannot flake or be chipped off.

Provided timbers are of large dimension, their behaviour in a fire can be superior to that of steel or reinforced concrete. A common cause of loss of life and major property damage is the buckling of steel members at quite low temperatures. This can lead to the early collapse of roofs or even the "pulling-in" of supporting walls—with disastrous results. Concrete is a bad heat insulator, and since the reinforcing bars or prestressed wires under tension are in the lower part, their failure due to heat is not long delayed. Treated timber, though damaged by fire, does not lose its shape, and the rate at which it loses its strength is extremely slow.

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To demonstrate the advantages of timber impregnated with Pyrolith flame retardant and timber preservative, a 16 mm. sound/colour film has been prepared by Hickson's Timber Impregnation Company (G.B.), Limited, Castleford, Yorkshire, and is available on loan. It covers the mechanics of burning, a method of protecting timber from fire, small-scale and large-scale fire tests demonstrating various aspects of Pyrolith's effect in preventing the rapid spread of flame, the method of treatment (vacuum/pressure impregnation), the uses of Pyrolith-impregnated timber in building, civil engineering, mining, shipping, etc., and comparison tests between a loaded Pyrolith-treated beam and light-alloy and steel beams of the same design strength in the presence of fire.

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SYNTHETIC-RUBBER PLANT FOR NORTHERN IRELAND

The decision of the Du Pont Company (U.K.), Limited, to establish a Neoprene synthetic rubber factory at Maydown, near Londonderry, will make a further contribution to the range of synthetic rubbers produced in this country and, although the capacity of the plant has not yet been announced, should result in a substantial reduction in dollar payments for imports of this material. In Weekly Survey of October 19, it was stated that the import programme for synthetic rubber in 1957 will amount to 80,000 tons. Plants already in production or planned to come into operation by 1958, excluding the new Du Pont factory, have a combined capacity of nearly 70,000 tons per annum and it would appear that by mid-1959 (when the Du Pont plant is scheduled for completion) the supplies of synthetic rubber will amount to between one-quarter and one-third of the total present consumption of synthetic and natural rubber.

In the United States the projected output of synthetic rubber by the end of 1957 is 1·5 million tons and already natural rubber accounts for only about 40 per cent. of total United States consumption. This figure is expected to fall to about 30 per cent. by 1960. The rapid expansion of synthetic-rubber production in the United States owes something to strategic considerations and to the abundance in that country of the raw materials, in the form of oil and natural gas, required by the industry. The growth in consumption of the synthetic product in this country, however, is due mainly to the great versatility of this material and the range of different types which can be produced for particular applications.

Neoprene is claimed to possess outstanding resistance to weather and to ageing and is used principally in hoses, seals, gaskets and cable insulation. In addition, owing to its resistance to flame and the propagation of fire, it is widely used in mine-conveyor belting, and its combination of stable dynamic properties over a wide temperature range make it suitable for many vibration insulation applications.

The erection of synthetic rubber factories will provide a good deal of work for structural engineers over the next three or four years. The erection of the Du Pont plant is expected to employ about 900 men. It was also announced at the end of November that Matthew Hall and Company, as sub-contractors to the Blaw-Knox Company of Pittsburgh, have been awarded the design and procurement contract, valued at £4 million, for the synthetic rubber plant to be built near Fawley for the International Synthetic Rubber Company.

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PRACTICAL TRIALS OF ALUMINIUM-TIN-COPPER BEARING ALLOYS

The results of road tests on a new aluminium-tin-copper alloy for bearings are detailed in the current number of "Tin and Its Uses," the quarterly journal of the Tin Research Institute, Fraser-road, Greenford, Middlesex. The material, designated the T.R.I. alloy, contains 21 per cent. of tin, 1·8 per cent. of copper, 0·15 per cent. of silicon, 0·13 per cent. of iron and the balance is aluminium. After promising results had been obtained from laboratory wear tests, arrangements were made to supply bearings for test purposes to the Rome Tramways. The new alloy was used for the axle bearings of a tramway car and in a year's running, during which the vehicle had covered 100,000 km. (62,000 miles) over one of the city's most severe routes, from the point of view of the damage and wear of bearings, it was apparent that these had withstood the hammering of the rail joints and the strain imposed by stopping and starting every four minutes without damage. Furthermore, it is stated that there was no sign of deformation nor of the typical more or less microscopic damage frequently found on used bearings. The sliding surfaces showed some scoring due to foreign particles, but no trace of seizing. Measurements made by means of a micrometer depth gauge showed that the wear was no more than 0·2 mm., and could be therefore classed as negligible.

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NYLON NUTS FOR STAINLESS-STEEL FITTINGS

For their range of stainless-steel fittings using a rubber ring or other sealing media, the Talbot Stead Tube Company, Limited, Green-lane, Walsall, are now adopting a nylon nut produced as a machined moulding. To obviate the difficulties arising in service from the fact that nylon absorbs moisture from a humid atmosphere, the nuts are fully saturated with moisture before dispatch. They are available in five sizes to suit 1 in. to 3 in. dairy-pipe fittings sizes, in black, blue or white for line identification. The adoption of nylon in place of stainless-steel nuts has resulted in a reduction in the price of complete fittings.

ORGANISING FOR RESEARCH

3—COMMUNICATING THE RESULTS

By E. I. Brimelow, M.ENG.

This is the concluding article of a short series reviewing the recent conference on the "Direction of Research Establishments," held at the National Physical Laboratory, Teddington. The previous articles appeared in ENGINEERING, *November* 16, 1956, *page* 617; *and November* 30, 1956, *page* 681. *The author is industrial and scientific liaison officer at the Laboratory.*

Among the problems discussed during the remaining stages of the conference were those relating to securing the most efficient and convenient buildings for the special types of research work in hand, and of finding the most satisfactory methods of communicating the results of the work accomplished.

In his paper reviewing factors relating to laboratory administration, Mr. E. S. Hiscocks,[9] secretary of the National Physical Laboratory, to whom credit is due for suggesting and organising the conference, referred to the comparative newness of this form of administration. The central problem in research organisations he felt, was to maintain the individuality of the scientist, upon whom the creativeness of the laboratory depended, while at the same time incorporating him into a highly organised system. Many of the major problems facing laboratory administrators were the result of the change in the magnitude of scientific research. There were, for example, problems of staff relations and the selection of staff; the development of formal patterns of work, based on functions rather than on personalities; and the responsibilities associated with large-scale capital equipment.

In addition, there were problems resulting from the peculiar nature of scientific work, as an activity of the mind. Underlying any administrative function must be the awareness that the business of a scientific establishment was to achieve the products of scientific thought, and the spearhead of such activities was formed by the scientists themselves. The emphasis, he maintained, should be on organisation as a service aiding the output of ideas.

Laboratory Administration

Criticisms were made during the discussion on this paper that genius could not, and probably ought not, to be organised. There was, however, a fair consensus of opinion that, in general, it was not genius that was being dealt with, since creative research workers probably accounted for no more than about 5 per cent. of the staff in a laboratory. Good organisation had a valuable part to play in easing the work of the other 95 per cent. straightforward hard-working scientists.

Ways in which good administration could help scientists were suggested by Mr. Hiscocks. He said that he was in favour of encouraging scientists to shed the less-skilled part of their work, so that they could devote additional time to more creative work, or those aspects of their work that they alone could do. This was not an easy matter, for, naturally, as a result of their training, scientists were reluctant to devolve responsibility and wanted to do everything themselves. Means of enabling scientists to give more time to creative work included the provision of central workshops and photographic facilities, and of information and library services, to enable them to keep up to date with the literature on their special subjects, and thereby to reduce the time they spent on searching for particulars of that kind. Arrangements could also be made for routine testing, and the collecting and handling of data to be dealt with by specially-trained assistants, who should use the most efficient machines for the purpose.

Just how far one could go in the division of labour was the subject of much discussion. Professor Dr. A. Schiebe, vice-president, Physikalisch-Technische Bundesanstalt, Braunschweig, put in a plea for the scientist who likes to do something himself, as he thought that the play-element in scientists was good for the scientists and for science. The same reasoning applied also to workshops and it was thought that it was, in general, a good thing that, in addition to the large central workshops, small workshops should be available, where scientists and their assistants could make up their own apparatus and novel pieces of equipment, even if the "string and sealing wax" technique was used. The subject of science and the workshop was also discussed in detail in the paper by Professor Dr. R. Vieweg,[10] President, P.T.B., Braunschweig.

Another aspect of the matter was that the need in modern research for large expensive equipment, such as wind tunnels, ship-testing tanks, high-speed automatic computers, cyclotrons and atomic piles, brought in its wake many operational and maintenance problems, and, in some cases, the need for organising shift work to ensure an adequate return for the large amount of capital outlay involved. The criticism was also made that such equipment tended more and more to dictate the programme of research to be done in the laboratory using it.

Budgets and Controls

In the view of Mr. D. R. Willson,[11] technical secretary, Atomic Energy Research Establishment, Harwell, budgets and administrative controls, however distasteful to the scientist, were as essential in a large research organisation as in any other concern. He made the important point that in budget preparation, just as much as in the operation of expenditure control, it was vital to get scientists to take a full share of responsibility.

In the ensuing discussion, there was a strong feeling that staff, at all levels, should be expense conscious and be made aware of what their facilities cost. Nevertheless, it was generally considered harmful for the external financial authority to exert too rigid a control on research programmes. There was some criticism from Mr. R. M. Winter, Imperial Chemical Industries, Limited, as to how closely a budget should be linked in detail with the items of research. He advocated that research managers should be given freedom, within the limits budgeted for, to adjust expenditure on each item, in order to allow for changes of emphasis as the work proceeded. Another delegate drew attention to the need of cost accounting, especially in the case of sponsored research. The difficulties of accounting for all expenditure within the strict limits of a financial year, particularly in regard to those of a capital nature, were also discussed.

In his paper, Mr. Willson made the point that all bodies must recognise the budgetary, legal, and any other limitations set by the organisation furnishing the money. He emphasised, however, that external constraints, imposed for their own convenience by individuals or groups, not understanding the basic requirements for successful research, could have a harmful effect on the work of a laboratory. A similar effect could arise internally from the actions of the research director and his senior staff. It had to be remembered that research laboratories were run primarily on keenness and enthusiasm; they were easily destroyed, but not so easily revived.

A basic requirement for good administration was to ensure that the research workers felt that their problems were understood; even though it might not always be possible to meet their wishes. A method used successfully at Harwell was to invite the more senior scientists to meetings devoted to administrative matters, at which the procedures in force were kept under constant review. Any proposed new instructions were presented at these meetings in draft form, to test the reactions of the staff and to allow for discussion before they were issued generally. Without competent administration, scientists could not have the right atmosphere, the right conditions and the right facilities to do the essential work for which the laboratory existed.

Designing the Buildings

The design and provision of buildings required for research was the subject of papers by Dr. F. M. Lea,[12] director of the Building Research Station, Department of Scientific and Industrial Research, and Mr. H. A. Snow[13], superintending architect to the Ministry of Works. These papers were complementary and to a certain extent they overlapped, but together they formed a useful guide for the provision of laboratory buildings. Dr. Lea made a number of useful suggestions for directors of research engaged in preparing a statement of requirements for the architect. He stressed the importance not only of planning for immediate requirements, but of allowing for possible future developments.

Such a course meant looking into the future and anticipating what the expected growth of the establishment's work was likely to be. The extent of this growth would naturally vary from one organisation to another; the work of a mature organisation, for example, should not be expected to develop as rapidly as that of a new undertaking. Another important aspect was what might be termed the flow of the work, since this might have a considerable influence on site layout and on the disposition of the various buildings in relation to the integration of the work done in them. He advised against starting with too small a site, since there were obvious advantages to be gained by allowing, as far as it was economically permissible to do so, for a certain amount of flexibility, both as regards the division of the space within the proposed buildings and in the provision of the staff's services. These precautions would then allow for an economical re-arrangement of offices and laboratories within the new buildings should this be required. Mr. Snow was also in favour of a master development plan, but he stressed the need for economy in building, especially at the present time because of rising costs.

It was easy for the architect to be blinded by the scientists' requirements. Very often these requirements could be met quite satisfactorily by types of buildings very different from those originally considered necessary, and with considerable economies. The need for such equipment as overhead cranes, and for special services such as compressed air and inert gas supplies, needed very careful consideration and the taking into account of the additional costs involved. It should be the responsibility of the architect to suggest alternative schemes, leading to economies, for the consideration of his clients.

Questions raised during the ensuing discussion included whether or not it was possible to standardise certain aspects of the building of laboratories, as in the case, for example, of laboratories to be used for general purposes; and the possibilities of adopting a standard dimensional module for buildings of this type. Problems associated with the heating, lighting and ventilation of research buildings were also discussed. It was felt that the kind of work to be catered for must have an important bearing on design, and useful details of various types of laboratories were given by some of the research directors present.

Making Information Known

Dr. A. King, head of the intelligence division of the Department of Scientific and Industrial Research, who served as chairman of the session on communications, summarised the

many aspects of communications required by science and their application. First, there was the manner in which they affected the individual research worker, such as how he obtained his background knowledge and how he made known his ideas to others. Secondly, there was the question of their effect on inter-staff and inter-group relations within a research organisation. He suggested, in this connection, that unless suitable arrangements were made for communicating experiences and results, there might be unhealthy insulation. Thirdly, there was the problem of obtaining the practical application of the results of research. This aspect of communications, although relatively easy of solution for large organisations, where there was close contact between engineers and scientists, was more difficult to handle in the case of small firms. It also raised the question of how information, having reached a particular firm, was to be dealt with to enable its effects to be taken into account in the company's production procedures. Finally, there was the effect of scientific communications on the general public: the popularisation of science was a much more complex problem than it was normally thought to be.

Reference to the important part which research management could play, at the peak of the organisational pyramid, in disseminating incoming information resulting from contact with the outside world at all levels was made by Dr. C. G. Williams,[14] director and general manager of "Shell" Research Limited. He suggested that the passing on of information, obtained as a result of these outside contacts, to colleagues who might be interested should become second nature to all research workers. The extent to which knowledge was communicated by personal contacts might well be regarded as a measure of the health of a research organisation, just as freedom from arterial obstruction might well indicate the state of health of a living being.

In addition to "horizontal" communication of that kind, there should be "vertical" communication, which was at least as important. The passing on of information, in fact, should operate both upwards and downwards, from the most senior to the most junior members of an organisation. Unless they kept in close contact with their staffs on the day-to-day development of the work, and found out how their workers were thinking about particular problems, the directors and group leaders would have difficulty in planning aright for future research.

Much good could come from the informal talks which research managers had during the visits they paid to research workers in their own offices and laboratories. On the question of the size of a group in relation to formal methods of inter-communication, it was suggested that, if formal methods were required at all in such circumstances, it was better that the group should be split up and the work dealt with in smaller groups.

Smaller Associations' Achievements

Dr. A. T. Green,[15] director, and Dr. A. E. Dodd, information officer, British Ceramic Research Association, provided a useful account of how a small research association could succeed in making known, in an efficient and practical manner, the results of its work to the industry it served. Among the various methods used were simply written reports, scientific papers, demonstrations, visits by technical liaison officers, and the formation of technical committees, all of which appeared, the authors considered, to be both suitable and practical for an organisation of that type and size.

Mr. A. J. Garratt,[16] liaison officer, N.P.L., described the liaison service at that laboratory. In this instance, the approach was similar to that of the B.C.R.A., but the sources of information used by the N.P.L. were somewhat different, in so far as that organisation was a large laboratory dealing with many subjects and serving industry in general rather than some well-defined section of it. To a large extent, however, it was found that the number of firms likely to be interested in a particular idea or development could be ascertained quite readily. The problem of serving industry in its wider aspects with the broad information issuing from a comprehensive laboratory, such as the N.P.L., was generally recognised as being a matter of some difficulty.

From the papers and the discussion on them, it appeared that the field liaison officer was, perhaps, the most practical method of disseminating information to firms. By this method of approach, it appeared that the greatest amount of attention could be secured and the chances of a new idea being accepted were then at their greatest, thereby securing economic, social and other circumstances in the idea's favour. When managements had been interested in this way, the written work became useful in providing the detailed follow-up information.

Impact of Scientific Journals

Mr. Louis Moss and Mr. L. T. Wilkins,[17] Central Office of Information, gave an account of a survey that had been undertaken to ascertain the attitudes of individual scientists and technologists in industry to communications problems generally and to scientific literature in particular. They drew attention to the sources of information used by the smaller firms in the electrical and electronic industry, and the interesting conclusion was reached that, on an average, only about five of the numerous journals printed were read.

During the discussion which followed, the printed word as a method of communication was vigorously attacked. It was said that too many new journals had been published since the war, that too many journals were now appearing, and that their motivation was directly commercial. It was agreed that the mass of material appearing in scientific journals, and, even in technical ones in some cases, bore little relation to the real needs of the smaller firms which had few, if any, technical employees, and that such literature, even when well scanned, had little immediate practical value to these firms. It was felt, however, that there was a need for critical reviews and the simple writing up of practical ideas.

There was much discussion, both for and against, regarding the popularisation of science and research results. On one hand, doubts were expressed as to the value of the popular Press as a suitable medium for the spread of new knowledge and ideas, while, on the other hand, the view was put forward that any publicity was better than no publicity. In his summing up, Dr. King said that, personally, he was surprised at the general acceptance of the limitation of the written word, especially as the machinery for communications in science still relied almost exclusively upon that medium. He felt that there had been no depreciation of printed communications when really detailed information was given, but, nevertheless, there appeared to have been a feeling throughout the discussion that scientists were relying too much on paper, the sheer bulk of which tended to discredit and conceal the value of the individual printed items.

Conclusions

The usefulness of a symposium, such as that held recently at the National Physical Laboratory, which is thought to be the first of its kind held in Europe, is that it brings into the open current ideas regarding the guiding principles for the good organisation and administration of research. This gathering placed special emphasis on those aspects of research which are likely to provide a healthier climate for successful scientific work; that is, successful as regards the output of creative ideas, and their development and application.

In his summing up at the final session, Dr. H. W. Melville, Secretary, D.S.I.R., drew attention to the large measure of agreement which had existed among those taking part in the discussions and, he suggested, perhaps one of the chief benefits arising from the symposium would be for those present to propagate the lessons they had learned to others.

It may be mentioned that the papers presented at the conference, together with a summary of the discussions on them, will be published in due course by H.M. Stationery Office.

References

Papers delivered at the symposium on the Direction of Research Establishments, at the National Physical Laboratory, Teddington, on September 26 to 28, 1956. The last three are not specifically mentioned in the text.

[1] Prof. J. D. Bernal, "Fundamental and Applied Aspects of Research Problems."
[2] Dr. Willis Jackson, "The Research Project: Choice and Termination."
[3] A. H. Wilson, "The Assessment of the Work of a Research Laboratory."
[4] Prof. D. J. van Lennep, "Personality and Social Factors Related to Creativity."
[5] Prof. Morris I. Stein, "Creativity and the Scientist."
[6] Prof. Herbert A. Shepard, "Superiors and Subordinates in Research."
[7] Sir Charles R. Harington, "Staff Groupings and the Flow of Authority."
[8] Stanley Mayne, "Incentives."
[9] E. S. Hiscocks, "Some Factors affecting Laboratory Administration."
[10] Prof. Dr. R. Vieweg, "Science and the Workshop." (Presented by Prof. Dr. A. Schiebe.)
[11] D. R. Willson, "Budgets and Administrative Controls."
[12] Dr. F. M. Lea, "Buildings: What is Required."
[13] H. A. Snow, "Building for Research: Design, Construction and Layout of Laboratories."
[14] Dr. C. G. Williams, "Internal Communications in a Large Research Laboratory."
[15] Dr. A. T. Green and Dr. A. E. Dodd, "Knowledge: Passing it On—Getting it Used."
[16] A. J. Garratt, "Extramural Communications."
[17] Louis Moss and L. T. Wilkins, "Studies in the Use of Technical Information in the Smaller Industrial Establishments."

Dr. W. S. Bristowe, "Selection and Personal Assessment of Staff, with Special Reference to Qualified Scientists and Engineers."

Dr. F. T. Rosser, "Staff Selection and Assessment."

M. W. Thistle, "Some Fundamental Difficulties in Popularising Science."

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OFFICERS OF THE ROYAL SOCIETY

At the anniversay meeting held on November 30, Sir Cyril Hinshelwood was re-elected President of the Royal Society, and Sir William Penney, K.B.E., director of the Atomic Weapons Research Establishment, Aldermaston, was elected treasurer in succession to Sir Thomas Merton, K.B.E. Sir David Brunt, chairman of the Electricity Supply Research Council of the Central Electricity Authority, was re-elected Physical Secretary, and among the members of Council elected were Sir Claude Gibb, K.B.E., chairman and managing director of C. A. Parsons and Company, Limited, Professor N. F. Mott, Cavendish professor of experimental physics, University of Cambridge, Professor L. Rosenhead, C.B.E., professor of applied mathematics, University of Liverpool, and Dr. B. F. J. Schonland, C.B.E., deputy director, Atomic Energy Research Establishment.

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WAVELENGTHS

As is common knowledge, the progress of radio communication of various kinds is hampered by the shortage of wavelengths and channels. Considerable interest will therefore be taken in a recent announcement by Mr. C. O. Stanley, chairman of Pye, Limited, Cambridge, that this firm has devised equipment which separates channels only 15 kilocycles apart. It will thus, it is claimed, be possible to increase the number of wavelengths available and lead to a development in all forms of radio communication. No technical details of the new equipment are at present available, but it is understood that it is the result of improvements in the use of precision quartz crystals and other components.

Book Reviews

MORE DESKS PER BENCH

Dynamic Factors in Industrial Productivity. By SEYMOUR MELMAN. *Basil Blackwell, 49 Broad-street, Oxford.* (22*s.* 6*d.*)

The national drive for increased productivity has had an exhortatory character and there has been little examination of the social and economic mechanisms with which, in practice, increased productivity has been associated. In an individual firm the decision to replace an existing machine or process by a new one may be made on immediate considerations of such factors as labour shortage, the need to increase output from a given floor space or particular bottle necks; but it will generally be found that behind these considerations is cost per unit of output and it is in this form that the problem generally presents itself to the production engineer.

In an attempt to generalise concerning the causes of increased productivity, Professor Melman, of Columbia University, has undertaken a valuable piece of research based on three hypotheses: that the degree of mechanisation of industrial work is controlled by the ratio of alternative labour to machine cost; that labour productivity is governed by the degree of industrial mechanisation so that productivity itself is a direct function of alternative labour and machine cost; and that the growth of administrative overhead has limited the effect of rising labour productivity on the output of goods per person.

His study, which confirmed these hypotheses, was based on examination of trends in a number of countries, chiefly the United States and United Kingdom, over a number of years, and on a detailed examination of the causes and effects of the introduction of mechanical handling equipment in the British motor-car industry. His findings, although perhaps not unexpected in their nature, are nevertheless startling in detail. For instance, between 1938 and 1950, while average earnings in manufacturing industries rose 155 per cent., the cost per hour of a 4,000 lb. electric fork-lift truck rose only 40 per cent. so that the number of machine hours equal in cost to a man hour rose 80 per cent. Similarly, between 1924 and 1938, the number of kilowatt-hours purchasable at the cost of an average industrial man hour increased from 11·2 to 20·3 and in 1950 had reached 35·6.

These changes corresponded to substantial increases in productivity, and Professor Melman demonstrates that they far outweighed any other cause of such increases. He clearly infers that such increases are always the result of external forces acting on business management and that, indirectly, the pressure for higher wages plays a major part. He even goes so far as to suggest that, when considering the installation of new equipment, the production engineer should consider the trend of wage rates during the life of the equipment in making his alternative cost comparisons.

On the causes of the rise in the proportion of administrative to production employees, Professor Melman discounts some popular explanations, such as the growth of technical staffs (which have contributed little) and the effect of Government regulation and enquires. The rise has been similar in both the United Kingdom and the United States, and appears to be due to the growth of new control and decision—making functions in firms due to pressures from labour, shortages of material, cost-accounting, and so forth. Between 1907 and 1948, the number of persons engaged on such work per hundred production workers in United Kingdom industry had risen from 8·6 to 20·0. There is no evidence that the situation is worse in nationalised than in private industry. Although between 1935 and 1948 the increase in the ratio for the coal mining industry was 86 per cent., it was only from the phenomenally low ratio of 2·3 per cent. to 4·3 per cent.; while in electricity supply the increase of 23 per cent. compared with one of 33 per cent. for manufacturing industry as a whole.

What is disturbing is that, although there appears to be no corrrelation between productivity and administrative overhead in either country, in the United Kingdom administrative overhead is rising faster than productivity, whereas in the United States the reverse is the case. Professor Melman emphasises that this is due to the higher rate of increase in productivity in the United States due to greater alternative cost pressure. A point could be reached in this country where the growth of productivity per production worker was accompanied by diminishing output per person employed.

Professor Melman discovered that within the motor-car industry there were substantial differences in administrative staffs and it appears that there is considerable scope for rationalisation and simplification of management organisation in industry. To some extent, it is to be hoped that the growing utilisation of office machinery, and in particular the electronic computer, will assist in retarding the free operation of this alarming special case of "Parkinson's Law."

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NUMERICAL ANALYSIS

Introduction to Numerical Analysis. By F. B. HILDEBRAND. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (8.50 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (64*s.*)

This book is an introduction in the sense that it covers a limited number of topics, but otherwise the general level of treatment is fairly high, being suitable for a mathematics graduate with no previous knowledge of numerical methods. The book deals mainly with the approximate representation of functions of one variable and the use of such approximations for interpolation, integration, differentiation and other miscellaneous processes.

The introductory chapter defines such elementary concepts as rounding error, truncation error, significant figures, etc. Chapters 2, 3, and 4 explore the consequences of approximation by polynomial interpolation, that is, the polynomial of degree n which coincides with the function at $n + 1$ pre-assigned points. The treatment is classical but includes a good analytical discussion of the truncation error of interpolation, a topic which receives rather stereotyped treatment in most books on numerical methods. Chapter 5 introduces difference operators and symbolic methods to derive the classical formulae for interpolation, integration, summation, etc. There is little here of any practical significance which cannot be derived more easily by classical methods, and for this reason symbolical methods might well be dispensed with. The same remarks apply to the rest of the material in this chapter, which is concerned with deriving alternative expressions for the truncation error of interpolation formulae. Chapter 6 describes difference techniques for the step-by-step integration of ordinary differential equations. The methods of Runge and Kutta are also described. In every case there is a very good discussion of the truncation error committed at each step, and the effect of the propagation error. Boundary value problems and linear characteristic value problems are also treated.

Of the remaining chapters, chapter 7 explains how the criterion of least squares leads to the use of orthogonal functions. The polynomials of Legendre, Laguerre, Hermite, and Chebyshev are introduced, and the circumstances in which one would employ them are described. The Gram polynomials (orthogonal over a discrete set of points) are described in connection with smoothing formulae. The next chapter, on Gaussian quadrature, indicates how high-speed computers have given a new lease of life to methods of quadrature which, although analytically elegant, were seldom used by desk computers. Chapter 9 deals with other methods of approximation (i.e., not based on polynomial approximation), e.g., approximation by trigonometric sums (harmonic analysis, periodogram analysis, economisation of power series), by exponential sums (suitable for the analysis of radioactive decay curves), and by continued fractions (rational functions). This chapter is valuable for the last topic alone, since continued fractions receive scant attention in most numerical works. The numerical solution of linear simultaneous equations and of algebraic equations is dealt with in the concluding chapter. Some elementary elimination schemes are described, but the more sophisticated aspects of linear algebra (including the determination of characteristic roots and vectors), is deliberately avoided. Iterative and relaxation methods for linear equations are mentioned, and several iterative processes for solving algebraic and transcendental equations are described.

A particularly valuable feature of the book is the selection of problems given at the end of each chapter. These range from routine calculations to analytical extensions of the theory. The book makes a very good impression, and is, we believe, one of the best works yet published in this field.

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NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

Engineering Inspection, Measurement and Testing. By H. C. TOWN and R. COLEBOURNE. *Odhams Press, Limited, 96 Long Acre, London, W.C.2.* (21*s.*)

This book is intended to cover the needs of practising inspection engineers and students of metrology. After expounding the function of the factory inspection department, the authors trace the development of recognised standards and principles of precision measurement. They deal with linear measurement, comparators and measuring machines, multi-dimension inspection machines, measurement during machining and automatic sizing, workshop inspection methods and calculations, angular measurements, testing straightness and flatness, screw-thread measurement and surface finish measurement.

V.H.F. Television Tuners. By D. H. FISHER. *Heywood and Company, Limited, Drury House, Russell-street, London, W.C.2.* (21*s.*)

With the advent of alternative television programmes, there arose a demand for a tunable set. This led to the development of tuner units, which may be mechanically separate from the main set. This book is believed to be the first to cover the subject in detail; it is divided into three main sections dealing with design, construction and service problems. Both switch and turret types are described.

The Economics of Electrical Installation Design. By GEORGE A. WEDGE. *Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, London, W.C.2.* (45*s.*)

Economics enters into all fields of engineering, not least that of installation. One of the objects of this book is to provide sufficient data to enable the designer to decide the most economic type of installation to fulfil any given purpose. It therefore discusses questions of building use, wiring methods, and tariffs, as well as lighting, power, and heating. Standard specifications and codes are included in the appendices.

Theory of Combustion Instability in Liquid Propellant Rocket Motors. By LUIGI CROCCO and SIN-I CHENG. Published for and on behalf of the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organisation, by *Butterworths Scientific Publications, 88 Kingsway, London, W.C.2.* (37*s.* 6*d.*)

In the first section of this monograph, the authors set out to establish a rational explanation for the existence of a detrimental and a non-detrimental type of rough combustion, to distinguish a number of mechanisms which may be responsible for the detrimental type, and to establish quantitative formulations for some of these mechanisms. The main part of the book is concerned with a detailed analysis of these theoretical developments, and covers

chugging (low-frequency instability), screaming (longitudinal high-frequency instability), and a comparison with experimental results.

Experimental Stress Analysis in the U.S.A. and Canada. Overseas Technical Reports No. 1. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.*2. (2*s.*)

This report describes current practice and new applications of experimental stress analysis in the United State sand Canada. It covers electrical-resistance strain gauges, photoelasticity, brittle coatings, analogy methods, miscellaneous methods, and refers briefly to high temperature effects in aircraft structures.

Sutcliffe's Manual of Belt Conveying. By HAROLD STREETS. *W. and R. Chambers, Limited,* 11 *Thistle-street, Edinburgh* 2. (25*s.*)

This book, based on the practical experience accumulated by Richard Sutcliffe Limited over the past 50 years, is intended mainly for the user of conveyors. It covers belt construction and selection, driving and tension gears and idlers, loading sections, feed and delivery chutes, belt cleaning gear, methods of discharge, various attachments, special applications, and use and maintenance.

The Economic Consequences of Automation. By PAUL EINZIG. *Martin Secker and Warburg, Limited,* 7 *John-street, Bloomsbury, London, W.C.*1. (21*s.*)

The author's aim is to foster the systematic study of the economic aspects of automation which, he contends, are not covered by the existing body of economic principles. He shows that there are fundamental differences between the economic effects of automation in an expanding and in a contracting economy and concludes that, although it would have dangers in a time of slump, it will not in itself cause a slump. In an inflationary period it should mitigate the consequences of overfull employment without causing widespread unemployment. His main conclusion is that it is of vital importance to survival as a free nation to " automate " with the utmost speed.

Temperature: Its Measurement and Control in Science and Industry. Vol. 2. Edited by HUGH C. WOLFE. Published for the American Institute of Physics by *Reinhold Publishing Corporation,* 430 *Park-avenue, New York* 22, *N.Y., U.S.A.* (12 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (96*s.*)

This volume comprises the proceedings of the Third Symposium on Temperature held at Washington, D.C., in 1954 under the joint auspices of the American Institute of Physics, the National Bureau of Standards, and the Office of Ordnance Research, U.S. Army. It contains 24 papers classified under general concepts, standards and scales, transient phenomena, experimental measurements, and miscellaneous topics—the latter including temperatures in atomic explosions, ionisation measurements at high temperatures and temperatures in the upper atmosphere. Among the more important developments reviewed are details of the 1954 international temperature scale, new determinations of thermometric fixed points, revisions of the magnetic temperature scale at very low temperatures, superconductors and semiconductors for temperature measurement, optical methods, and temperature measurements in engineering. Vol. 1 contains the proceedings of the preceding symposium in 1939.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Welding Equipment. ENGLISH ELECTRIC CO. LTD., Stafford. Equipment for arc welding—portable or stationary; single or multiple operator sets up to 600 amperes continuous rating. Also accessories including electrodes, masks, shields, holders, chipping hammers and gloves. Publication WA/129 includes notes on installation and probable causes of faults.

Sand and Gravel. SAND AND GRAVEL ASSOCIATION OF GREAT BRITAIN, 48 Park-street, London, W.1. Formerly the Ballast, Sand and Allied Trades Association; the name has been changed to one more accurately describing the activities of the members. Association's history, objects and achievements; members and other data. Booklet.

Armoured Plastics Cables. TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. LTD., Mercury House, Theobald's-road, London, W.C.1. Wire armoured cables with polythene sheathed cores and P.V.C. outer sheathing. 250 and 660 volt grades, 2, 3 or 4 core with conductors from 3/0·029 to 19/0·064. Publication A.P.C./1.

Railway Signalling Equipment. WESTINGHOUSE BRAKE AND SIGNAL CO. LTD., 82 York-way, King's Cross, London, N.1. New and revised pamphlets for items of signalling equipment covering levers, relays, housings, hand generator and Neale's block instruments. Ten brochures in all.

Cableship. SUBMARINE CABLES LTD., Mercury House, Theobald's-road, London, W.C.1. Details and history of the cableship " Ocean Layer " including the story of her conversion. Plans and a full description of the vessel are given with notes on the machinery. Illustrated booklet.

Chains for Conveyors. W. G. JENKINS & CO. LTD., Retford, Nottinghamshire. De Brouwer chains for drag-bar conveyors for handling coal, ash, slurry and similar materials. Standard types and capacity nomograph for different sizes. Illustrated brochure.

Resistance Thermometers. SAVAGE AND PARSONS LTD., Watford, Hertfordshire. Platinum resistance thermometers with overall accuracy of ± 1 per cent. and sensitivity of ± 0·1 deg. C. Four models covering the range from − 50 deg. C. to + 150 deg. C. Leaflet 3/5.

Cable Glands. ELECTRICALS LTD., 14 Claremont-place, Newcastle-upon-Tyne 2. Compression cable glands for colliery, shipyard and industrial use. Types for S.W.A., braided or unarmoured cables; conduit connection for sizes up to 1¼ in. Illustrated leaflet.

Electro-Magnetic Pilot Valves. BALDWIN INSTRUMENT CO. LTD., Brooklands Works, Dartford, Kent. Solenoid-operated pilot valves for air or oil systems. Seat diameters from $\frac{1}{16}$ in. to $\frac{1}{4}$ in. and working pressures from 15 to 250 lb. per sq. in. Illustrated catalogue.

Glass Wool Air Filter Media. AIR CONTROL INSTALLATIONS LTD., Ruislip, Middlesex. Amerglas, made by American Air Filter Co., replaceable-media air filter. Glass fibre, thermoplastically bonded, of progressive density from front to back, entrapping dirt all through the thickness of the filter pad. Illustrated descriptive leaflet.

Bogie-Hearth Furnaces. GIBBONS BROTHERS LTD., P.O. Box 19, Dibdale, Dudley, Worcestershire. Typical recent examples of gas, oil, or coke-fired bogie-hearth furnaces for stress-relieving, annealing and normalising treatment. Illustrated leaflet.

Motor Control. THE MEDICAL ENGINEERING CO. LTD., 4 Fountayne-road, Broad-lane, London, N.15. " Mecontrol " electronic control units for fractional horse-power motors from $\frac{1}{150}$ to $\frac{1}{2}$ h.p Full torque over speed range of 100 : 1. Leaflet.

Storage Racks. GEO. H. GASCOIGNE CO. LTD., Berkeley-avenue, Reading. " Kee Klamp " units for constructing storage racks. Seven sizes to take tubes from ⅜ in. to 2 in. nominal bore. Can be supplied galvanised or natural colour. Folder.

Soil Testing. SOILTEST INC., 4711 W. North-avenue, Chicago 39, Illinois, U.S.A. " Versa-Tester " for making compression tests on soils and allied materials; machine capacity 30,000 lb. Hydraulic power. Illustrated leaflet.

Rubber for Roads. NATURAL RUBBER DEVELOPMENT BOARD, Market Buildings, Mark-lane, London, E.3. Advantages of rubberised bitumen for road construction and notes on the techniques to be adopted in laying such roads. Illustrated booklet.

Workshop Gauges. A. CAPP AND SON, LTD., Thames-road, Crayford, Kent. " Verdict " gauges and allied products: dial indicators, measuring equipment; tooling jigs and fixtures; calipers. Illustrated catalogue.

Tubular Buildings. UNITED MERCHANTS LTD., Walter House, 418/422 Strand, London, W.C.2. Use of tubular members for constructing agricultural and industrial buildings; data sheets for design. Handbook.

Nylon Ropes. BRITISH NYLON SPINNERS LTD., 25 Upper Brook-street, London, W.1. Nylon ropes for all purposes; strength, light weight and immunity to attack by water, alkalis, oils and some acids. Booklet.

Railway Traction. ENGLISH ELECTRIC CO. LTD., 28 Kingsway, London, W.C.2. An illustrated brochure of electric and Diesel-electric locomotive and motor coaches made by the company and its associates. Publication T.D.130.

Fire Detector. MINERVA DETECTOR CO. LTD., Richmond, Surrey. Fire detection system employing an ionisation chamber which is affected by smoke, this triggers a balanced circuit and sounds an alarm. Booklet.

Remote Control Cables. COMPOFLEX CO. LTD., 23-25 Northumberland-avenue, London, W.C.2. Metallic flexible spring-return controls, push-pull controls, and speedometer tachometer controls. Illustrated technical data book for the designer.

Corrugated Translucent Sheeting. GLASS FIBRE PRODUCTS (LONDON) LTD., 4 Upper Belgrave-street, London, S.W.1. Fibrelite resin-bonded glass fibre corrugated translucent sheeting for skylights and windows. Illustrated specification leaflet.

Civil Engineering Plant. CATERPILLAR TRACTOR CO. Peoria, Illinois, U.S.A. Tractors and motor graders; track-laying plant up to the largest sizes obtainable. Brochures.

Foreign Language Catalogues. CROFTS (ENGINEERS) LTD., Bradford, Yorkshire. Catalogues of Radiation gear units are available in many languages and with dimensions in metric figures.

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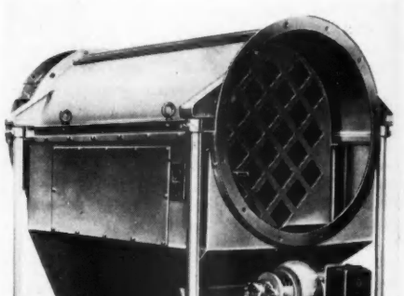
AIR HEATER

The oil-fired air heater shown in the accompanying illustration has recently been put on the market by Vaporheat Limited, 47 Victoria-street, London, S.W.1. It is the first of a series designed primarily for ducted systems and particularly for use in conjunction with the range of Aerofoil fans made by Woods of Colchester, Limited. Space heating or industrial drying are probably the main applications of this type of unit, which has a heat exchange efficiency of between 77 and 85 per cent. The



The COB 300 air heater is designed primarily for use with ducted systems. It is oil fired and has an output of 300,000 B.Th.U. per hour.

operation is entirely automatic under the control of a thermostat, time clock or the like.

The model illustrated, the COB 300, has a 30 in. diameter casing and a heat output of 300,000 B.Th.U. per hour. With an air flow of 8,000 cub. ft. per min., a temperature rise of 34 deg. F. can be obtained, increasing to 98 deg. F. for a flow of 2,500 cub. ft. per min. against a pressure of 5·5 in. water gauge. Other models will have 24, 38 and 48 in. diameter casings and will cover heat outputs from 175,000 to 1,200,000 B.Th.U. per hour. The fuel used is gas oil with a viscosity of 35 secs. Redwood No. 1 at 100 deg. F., and the 30 in. model consumes 2¼ Imperial gallons per hour. The burner is one of the MDE range made by Vaporheat Limited. Heat-resisting stainless steel has been used for the construction, and the casing design illustrated is that normally used in conjunction with single-stage fans. The unit is supplied complete with photocell protection for flame failure; air output-temperature control thermostat; fan-and-limit control switch; and direct-on starter.

DETERMINING THE TENSION IN ROPES

CONTINUOUS RECORD OBTAINED WITH INSTRUMENT DEVISED BY B.I.S.R.A.

By H. N. Wilkinson, B.SC. (ENG.)*

An investigation into the design of grabs has been proceeding for some time using models in the laboratory, and in order to correlate the results obtained in this way with full-scale practice, a limited number of tests on full-size grabs had to be conducted. Such tests required the measurement and continuous recording of the tension in the closing ropes of the grab. While a number of instruments are commercially available for measuring rope tension,† none gives a continuous record, and so a special rope-tension recorder was developed.

A suitable instrument must (i) measure and continuously record fluctuating rope tensions up to 15 tons with an error not exceeding 5 per cent.; (ii) be suitable for operation with wire ropes up to 1 in. and preferably 1½ in. diameter (i.e., 3 in. to 4½ in. ropes); (iii) operate satisfactorily at rope speeds up to 400 ft. per min., the maximum normally encountered on cranes, transporters, etc.; and (iv) be simple, light, robust and suitable for handling and mounting in position on the rope under test, in elevated situations difficult of access.

PRINCIPLE OF OPERATION

The principle of operation is shown in Fig. 1. The rope the tension of which is to be measured, is deflected around three sheaves, the outer two being fitted to the side plates of the instrument and the central one attached to a fork arm which can slide freely between them. At its other end the fork arm centrally loads a simply-supported beam which has strain gauges attached. The load W on the beam and therefore the strain in the gauges is proportional to the rope tension T and the angle of deflection of the rope around the sheaves θ, according to the relationship $W = 2T\sin\theta$. By connecting the strain gauges to suitable measuring and recording equipment a continuous record of rope tension is obtained.

Several modifications in detail have proved necessary since the design of the rope-tension recorder was originated. An entirely different method of recording the variation in rope tension was formerly used. In this system the deflection of the loading beam was transmitted by the fork arm to a 30: 1 ratio pen arm which gave a trace on a recorder chart fitted to one of the side plates. In order to obtain significant readings it was necessary to have a large angle of rope deflection, especially when small rope tensions were being measured. This required large sheaves and large side plates of sufficient strength.

The instrument was fairly satisfactory on laboratory rig tests, but when used to measure the tension in the wire ropes of an excavator it proved to be inadequate. Side movement of the fork arm and backlash in the pen arm mechanism resulted in spurious readings. In addition, the pen arm and recorder chart were themselves a constant source of trouble, being unable to give good service under the very severe operating conditions.

By substituting strain gauges several advantages were gained. The recording apparatus was kept entirely separate from the instrument, and no moving parts were involved, while a much smaller angle of rope deflection could be used. Further modifications made as experience was gained, included extra guide rollers for the fork arm, ball loading of the beam and means of ensuring a constant angle of rope deflection. These details are described below.

CONSTRUCTION

The instrument is shown in Figs. 2 to 5. The two side plates are machined aluminium-alloy castings, joined by cross pieces. Sheaves of Meehanite iron, to give good wear properties, are mounted on ball bearings, one at each end between the side plates. The loading beam is also of aluminium alloy (BA/WP/25). At each end are knife edges which bear in grooves in the underside of the cross pieces. On these latter members blocks are mounted to prevent the beam moving laterally. Strain gauges are attached to the beam, as described later. The central sheave is identical with the two outer ones, and is mounted at one end of the fork arm. At the other end is the bearing plate which applies the load to the loading beam through a hardened-steel ball. All but longitudinal movement of the fork arm is prevented by guide rollers on the inside face and on the top edge of the side plates.

The bearing plate has of necessity to be fitted on to the fork arm after the latter has been mounted over the rope under test. A handwheel arrangement, which can be removed when not

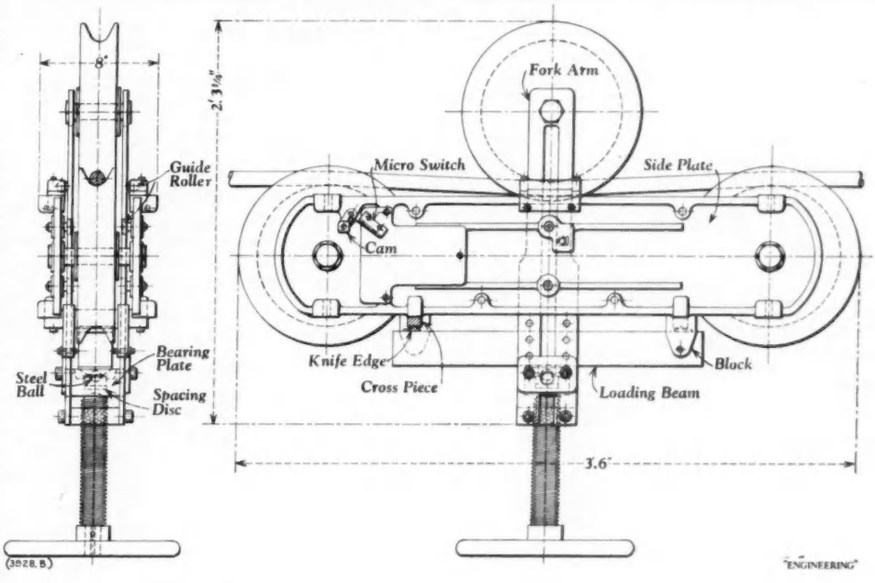


Fig. 2 (above) General arrangement.

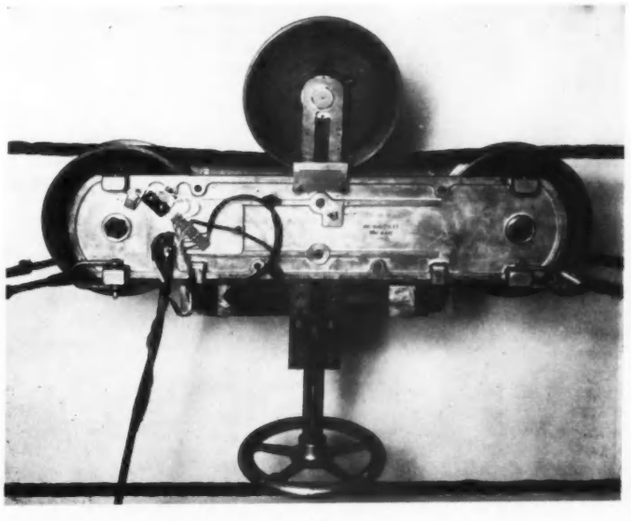


Fig. 3 Side view.

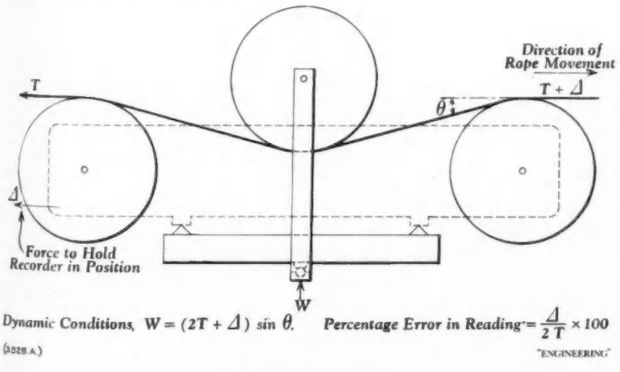
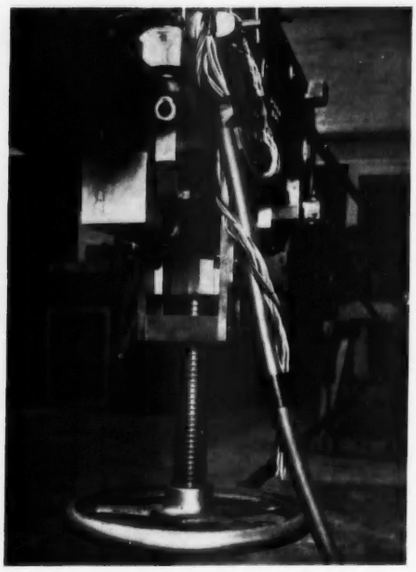


Fig. 1 Principle.

Figs. 1, 2 and 3 This rope-tension recorder, designed for obtaining a continuous record of the load in the closing lines of grabs, depends on the measurement of the strains in a steel beam deflected according to the pull in the line.

* Of the British Iron and Steel Research Association. The article is based on B.I.S.R.A. Report No. PE/H/10/56, "A Rope-Tension Recorder".

† Burgess, H. J., "Crane Weighers," B.I.S.R.A. Report No. PE/D/56/53.



Figs. 4 and 5 End views of rope-tension recorder from above and from below.

required, enables this plate to be adjusted into the desired position against the resistance offered by the rope tension. The plate can be secured with Allen screws in any of a series of holes in the fork arm, but for a reason which will be given later only the lowest set is used, giving an angular deflection θ of the rope of 3 deg. 12 min. Spacing discs can be inserted between the steel ball and the bearing plate so that for rope sizes from $\frac{3}{4}$ in. to $1\frac{1}{4}$ in. the deflection is constant.

STRAIN EQUIPMENT

Two pairs of strain gauges were cemented with "Araldite" to the loading beam, in the positions shown in Fig. 6, one pair being a duplicate of the other. One gauge of each pair is attached to the top of the beam and the other directly underneath it to give temperature compensation, and at the same time double the sensitivity. Short leads were soldered to the strain gauges, which can thus be connected when required to cables leading to the electronic equipment. As protection against the weather the strain gauges were thoroughly covered with "Dijell," a wax-like waterproofing compound. They were then sealed with a small piece of oilskin cloth, and the whole wrapped around with adhesive tape.

Electronic measuring and recording equipment supplied by Southern Instruments Limited, is used. Two separate channels are available to allow each pair of strain gauges to be connected separately to form two arms of a Wheatstone bridge, the ratio arms being in the appropriate measuring bridge unit. The output of the bridge feeds the amplifying equipment of the two-channel cathode-ray oscillograph recording unit, the variation in strain-gauge resistance (and therefore in rope tension) being recorded on a photographic paper 70 mm. wide which can be run at a range of speeds up to about 30 ft. per min., as required. A reading on a galvanometer is also available when a continuous record is not required.

The change in the resistance ΔR of the strain gauge is related to the change in the strain of the gauge ΔF according to:

$$\Delta F = \frac{E}{K}\frac{\Delta R}{R}$$

where E = Young's modulus for the beam material, $10{\cdot}5 \times 10^6$ lb. per sq. in.
K = strain gauge factor = 2·12
and R = strain gauge resistance = 1,000 ohms. (nominal).

The strain gauges were supplied by H. Tinsley and Company, Limited. They are type 7A, which are 59 mm. long. A micro-switch, operated by a cam driven off one of the sheaves, is used to measure the length of rope passing through the rope tension recorder. Normally a nominal 50 cycle per sec. wave form is recorded on the time marker tube provided with the Southern Instruments equipment, but closure of this micro-switch removes it by shorting out the supply.

A calibration rig was constructed in the laboratory to simulate conditions on a crane or transporter. A 1 in. diameter long-spliced endless rope of 6 × 37 construction was mounted around two large pulleys, having an inside groove diameter of 30 in. and the centres being approximately 25 ft. apart. At the driving end of the rig the bearings supporting the pulley were bolted to a fixed stand as shown in Fig. 7. The drive was obtained from a variable speed direct-current motor through a 15 : 1 reduction gearbox, giving an infinitely variable speed range at the pulley of approximately 0 to 50 r.p.m. corresponding to a rope speed of 0 to 400 ft. per min. The bearings of the other pulley were bolted to a framework which rested on another fixed stand, and were free to slide in guides over the top face. Tension could be applied to the rope by means of two screw-threaded members operated by spanners, which bore up against the end of the framework through two hydrostatic load meters (Fig. 8). These consisted of oil-filled steel capsules connected to pressure gauges reading from 0 to 2,000 lb. per sq. in., suitably calibrated.

The rope tension recorder was lashed into position on the laboratory rig as shown in Fig. 7. A rough measurement of the force required to hold it in position when the rope is moving gave a value of approximately 2 per cent. of the rope tension when θ = 3 deg. 12 min. This results in an error of 1 per cent. (Fig. 1), which is within the range of accuracy expected from the instrument. It was considered that this error could be neglected provided settings involving higher values of θ were not used. Calibration up to 15 tons was required, but the rig was not suitable for loads in excess of 5 tons. Tests up to this lower limit, both static and dynamic, were carried out. These showed that the calibration was not materially affected by rope speed, and no critical speed was encountered. An estimate of the calibration at rope tensions up to 15 tons was obtained by calibrating the loading beam alone under a hydraulic press with a proving ring, using the previously mentioned formula $W = 2T \sin. \theta$. The effect of fluctuating loads was examined by repeated loading and unloading of the beam. It was found that the calibration followed a hysteresis loop, repeated cycles following the original curve (Fig. 9). In its present form therefore the instrument is not suitable for accurate measurement of fluctuating loads. For calibration purposes it was generally more convenient to obtain readings from the galvanometer rather than the C.R.O. unit, and results are given in terms of galvanometer divisions.

PERFORMANCE

During a recent series of tests associated with research into grab design*, the rope tension recorder was used to measure the tension in the closing ropes of grabs fitted to a 24 ton ore transporter at the works of the Steel Company of Wales, Port Talbot. It proved to be satisfactory for this purpose when rope tensions up to 11 tons

* Wilkinson, H. N., and Carrier, A. G. E., "Tests on Grabs Digging into Iron Ore," B.I.S.R.A. Report No. PE/H/7/56.

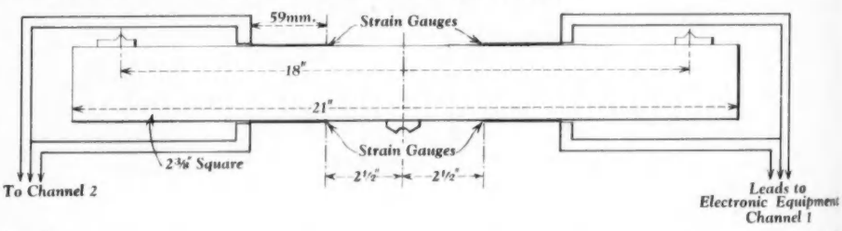


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Fig. 6 Position of strain gauges on loading beam; the deflection of the beam, and hence the strains, are a measure of the load in the rope.

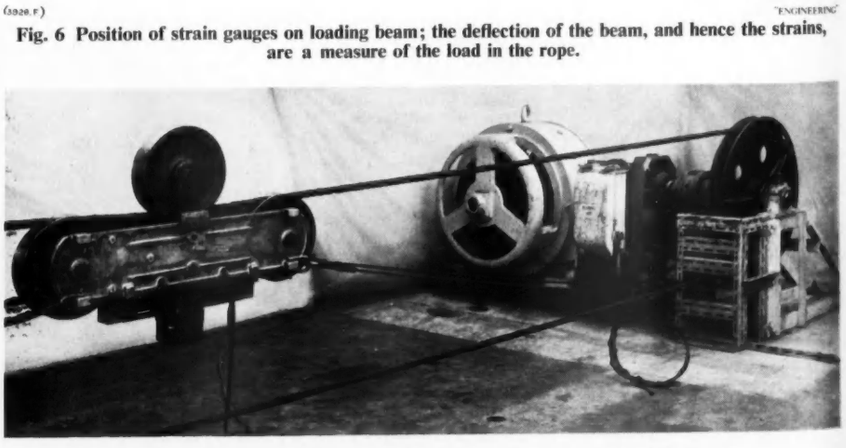

Fig. 7 The recorder on the calibration rig, as seen from the driving end.

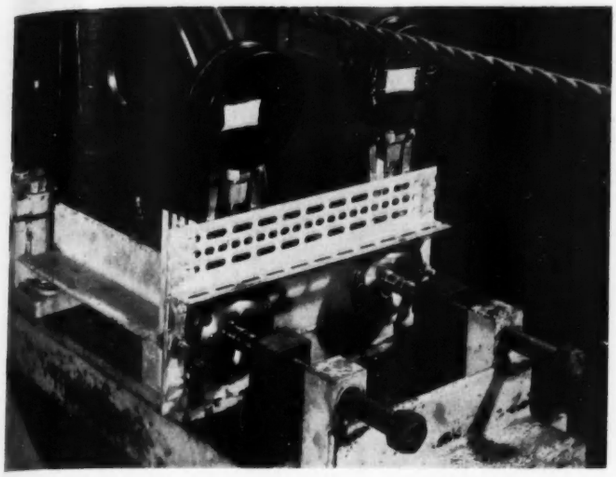

Fig. 8 The driven end of the rig used for calibrating the rope-tension recorder. The tension in the rope is applied by tightening the two screw members which bear against the framework through hydrostatic load-meters, fitted with calibrated pressure gauges.

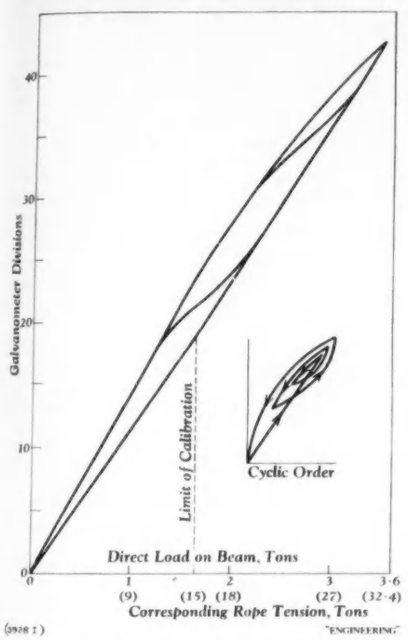

Fig. 9 Calibration of loading beam showing hysteresis loops.

and rope speeds up to 230 ft. per min. were encountered. When used on these tests the calibration was checked against a known rope tension of 5 tons, and found to be correct to within 1 per cent. Even so, if close accuracy is required, it is considered that a check calibration should always be made for the higher ranges of rope tension, and in every case of change in rope diameter, since the precise effect of the rope stiffness, and of the rope flattening as it passes over the sheaves, is not known.

The instrument is larger than is really necessary, but with the modifications now incorporated a smaller one could be produced. In its present form it is strong enough to measure tensions up to 45 tons, although these are hardly likely to occur in ropes of sizes up to 1½ in. diameter. The design is simple and robust so that the instrument can work satisfactorily in all weather conditions. The use of strain gauges involves the acceptance of electronic measuring equipment, but this is sometimes advantageous since it can be placed under cover and out of the way of operations.

Acknowledgments.—The author wishes to give credit to Mr. H. J. Burgess, formerly of the Mechanical Section, Plant Engineering Division, B.I.S.R.A., and to Mr. B. H. Poulten, formerly of the Drawing Office, Battersea Laboratories, B.I.S.R.A., for the original design of the rope-tension recorder. In addition, thanks are due to British Ropes Limited, for assistance in certain details of the design, and to Mr. R. C. Johnson of the Electrical Section, Plant Engineering Division, B.I.S.R.A., in the operation of the electronic equipment.

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LIGHTWEIGHT CORES FOR SANDWICH CONSTRUCTION

Paper, Aluminium, and Glass-fibre Honeycomb

During the second World War, in seeking a technique for making aircraft drop tanks from paper, a method of making structural honeycombs was developed by Mr. George May, then with Dufay Limited, and the product was named Dufaylite. To-day, Dufaylite honeycomb cores are made not only in paper—both untreated and resin-impregnated—but also in aluminium and glass fibre; and, unlike the majority of honeycomb materials, they can be used for simple and double-curvature constructions. They are now made and marketed by Dufaylite Developments, Limited, Boreham Wood, Hertfordshire, a company formed just over a year ago to exploit the large untapped market for material of this type.

The qualities claimed by the manufacturers for Dufaylite are lightness combined with rigidity, dimensional stability, good shock absorption, exceptional moisture resistance, high fire resistance, good heat and sound insulation and resistance to vermin and pests. Dufaylite is already widely used in the aircraft industry as a structural core material, one of the most interesting applications being in the rotor blades of the French Ouest Aviation Djinn helicopter, where its ability to stand up to vibration is a great advantage. Fibre-glass Dufaylite cores, as a result of their dielectric properties and dimensional stability, are extensively used in the construction of radomes. Dufaylite is also being adopted increasingly for such uses as partition walls and lightweight building panels both in the building industry and for ship and railway coach construction.

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MAGNETIC STARTERS

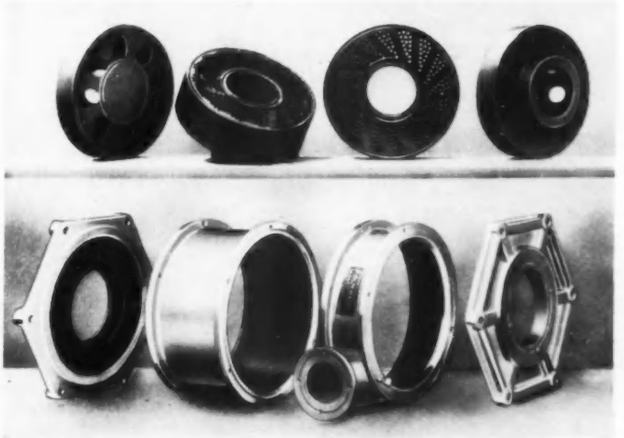
A new range of magnetic reversing starters for use with squirrel cage motors has been put on the market by Square D, Limited, 100 Aldersgate-street, London E.C.1.

The starters consist of two standard contactors mounted on a common steel base and both electrically and mechanically interlocked. One is used for forward and the other for reverse. A normally-closed auxiliary switch is mounted on each contactor and is wired in series with the opposite contactor coil to prevent accidental energising of both at the same time. Overload relays are also fitted. Additional auxiliary switches can be used for interlocking or indicating systems.

HEAT EXCHANGER WITH GRAPHITE INTER-FACES

A heat exchanger, which makes use of a drilled graphite block as the inter-face, is now being made in this country by Robert Jenkins and Company, Limited, Rotherham, Yorkshire. Known as the Polybloc, it has been made up till now by Carbon-Lorraine, 45 Rue de Acacias, Paris, 17. Basically, it consists of a metal shell within which are placed in succession a graphite header, one or more pairs of heat exchange blocks, and then a second header. The component parts are shown in the accompanying illustration. The heat exchange blocks are separated by sealing rings and each pair from the next by a graphite obstruction disc, so that the direction of flow of liquid through the radial holes is reversed at each pair. The other exchange liquid flows through the axial holes and the blocks are set so as to obtain the maximum turbulence. There are no cement joints nor is there any difficulty with differential expansion; corrosive fluids can safely be handled as these contact the graphite only.

Two sizes of model are made: the standard and the small. In the standard, for two exchange blocks, the heat exchange area is 11 sq. ft. for each of the fluids. As many as 20 blocks can be used in which case the overall length of the exchanger reaches 7 ft. 8¼ in. Overall diameter is 19 in. in the standard model and 9¼ in. in the small.



Drilled carbon blocks form the exchange surfaces in the Polybloc heat exchanger. They are mounted in a steel shell. One fluid flows through radial holes in the blocks, the other through the axial holes.

MECHANISED PRESS AND WELDING SHOPS FOR MOTOR BODIES

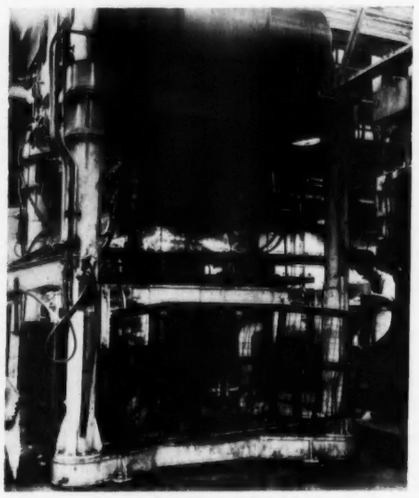


Fig. 1 Adjustable stroke 80 in. by 80 in. hydraulically-operated welding press for the inside door-panel assembly for motor cars.

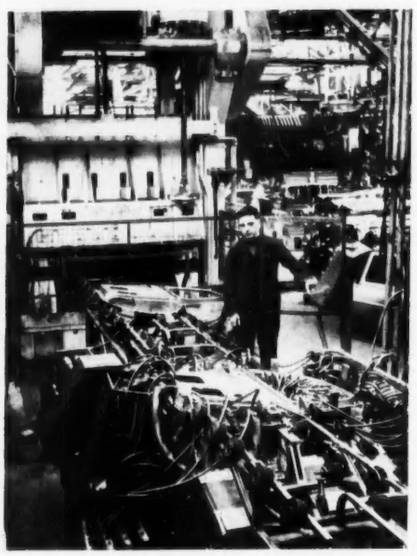


Fig. 2 Final-assembly welding machine for motor-car doors. Roller conveyor in foreground.

Formed in 1930, the firm of Briggs Motor Bodies, Limited, Dagenham, Essex, became a subsidiary company of the Ford Motor Company, Limited, in 1953, and during the past few months certain developments and extensions have been taking place. Thus, mechanised transfer equipment has been specially designed and introduced into the main motor-car body press shop to make for safer working conditions and to reduce operator fatigue. Other considerations are increased efficiency and orderliness, it being pointed out also that the provision of a clean shop layout reduces the possible damage to body panels and assemblies to a minimum. The management add that the new equipment has already resulted in increased productivity. In line with these developments, conditions of assembly, by welding, have been created in the adjoining welding shop which allow the most efficient use to be made of the labour and the storage space available, consonant with the final body-building schedule.

PRESS SHOP

The transfer equipment in the press shop comprises mechanical loading and extracting equipment, turn-over devices and conveyors. The loaders are electrically operated and feed the presses under conditions of safety to the operators. In this way car doors and body panels are produced and are withdrawn from the press by specially-designed extractors. Most of these have an air cylinder for the prime mover and this provides an efficient pneumatic cushion. Extractor jaws, adjusted for height and tilt, and having the requisite length of stroke, grip the stamped panel and deposit it on a turn-over or direct on to a belt conveyor. For some of the larger panels a "full-bridge" extractor, as it is called, is fitted with two extractor jaws which grip each outgoing corner of the panel, thus ensuring that the piece is extracted squarely.

The belt conveyors used to link the operations of the various presses have a uniform speed of 50 ft. per minute and they are all capable of being inclined, thus giving full height adjustment. The widths of the conveyors are 3 ft., 4 ft. and 5 ft. and their lengths vary from 12 ft. to 24 ft. Some are equipped with an automatic stop which arrests the driving motor when a panel reaches the end of the belt. The control circuit also permits a number of conveyors to be linked so that, when a panel reaches the end of the last conveyor in a chain it stops the whole chain.

It may be of interest to give, as an example, a typical sequence in the press shop. It is that producing outside panels for car doors. Square sheared steel-sheet blanks are supplied to a double-action press which heads this production line. An operator slips a blank on to the loader, standing in front of the press, and operates two palm buttons. These set the loader and the press in motion simultaneously. While the sheet is in the press the extractor carriage, at the rear, comes to the forward position bringing the extractor jaw to within approximately $\frac{1}{2}$ in. from the die. As the ram of the press rises some lifters also rise, lifting the drawn panel ready for extraction. The extractor jaw grips the panel and the extractor trolley moves back, carrying the panel with it. On the return stroke the carriage depresses a limit switch which breaks the extractor jaw circuit, thus depositing the panel on to a turn-over mechanism. This deposits the panel the right way up on to a 4 ft. wide conveyor, 12 ft. in length. When the panel arrives at the next press it is manually loaded on to a trimming die. Once more it is raised on the up stroke of the press and extracted by a jaw which hooks under the panel to avoid marking its surface. It is taken to the next press for the flanging operation by a 4 ft. conveyor, 17 ft. 6 in. in length, after which further conveyors take the panel to a point at which it is loaded on to an overhead conveyor for further treatment. The sequence enables 420 panels to be produced in an hour.

WELDING SHOP

In dealing with the welding shop we propose to concentrate our attention on some of the more important machines installed, rather than try to give a brief description of all the equipment available.

The mechanised multi spot-welding equipment provided has been standardised as far as possible to facilitate matters for the maintenance, production and inspection staffs and to simplify the design of the tooling and the provision of spare parts. Three types of welding presses are available, namely, 84 in. by 186 in. by 30 in. stroke fully-hydraulic machines; 80 in. by 80 in. by 12 in., 18 in., or 24 in. adjustable-stroke presses, operated hydraulically but in which the table-rise mechanism is link-operated and the table weight is mainly overcome by four balancing air cylinders; and smaller open-fronted all-hydraulic presses. Some 98 per cent. of the multi-welding equipment employs 45 kVA 50 per cent. duty cycle transformers, while the

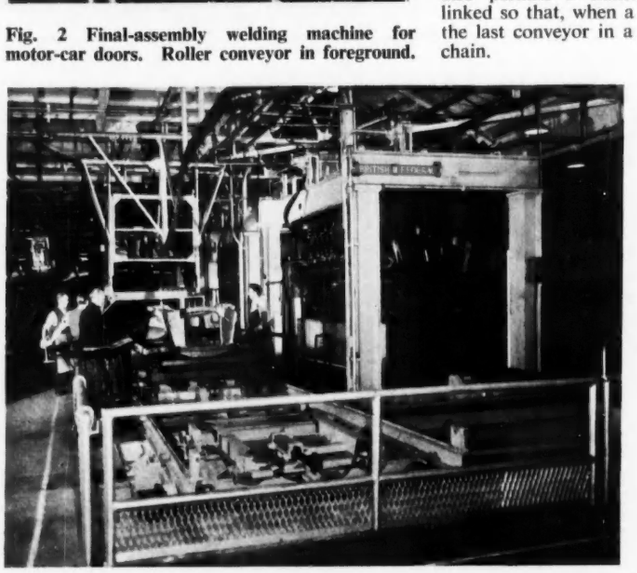


Fig. 3 Underbody welding-press line from the loading end, showing a trolley in a loading position and the transfer mechanism in the foreground.

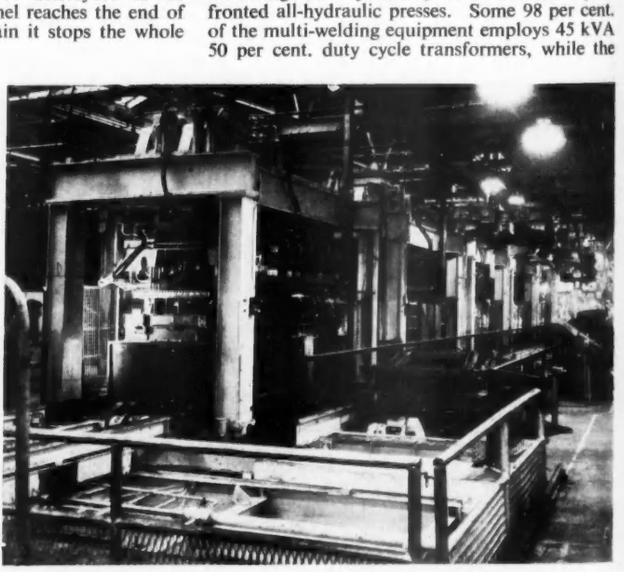


Fig. 4 Underbody welding-press line from the unloading end, showing the five presses in line and a trolley on the return conveyor.

remainder utilises 65 kVA 50 per cent. duty cycle transformers.

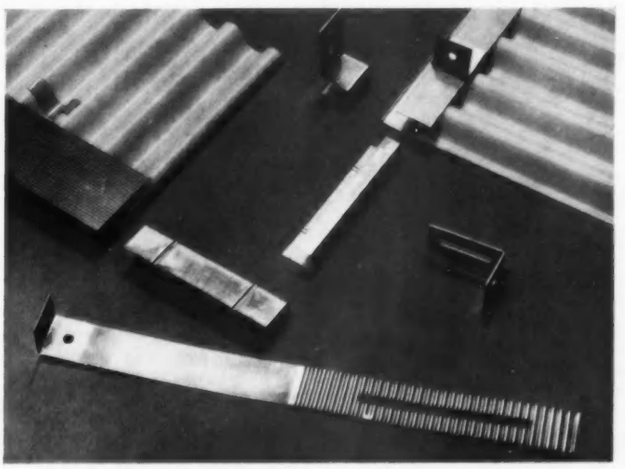
One of the two 80 in. by 80 in. welding presses is seen in operation in Fig. 1. In these, inside door panels are assembled from stampings received from the press shop. The doors are then passed by roller conveyor into the final welding machine seen in Fig. 2.

The largest assembly line in the welding shop is that in which the underbodies of motor cars are dealt with. It consists of five welding presses, with a transfer mechanism at the beginning and end of the line, and a return conveyor which includes loading and unloading stations. The underbody welding line is seen from the loading end in Fig. 3; a trolley is shown in the final loading position and the transfer mechanism is seen in the foreground. The unloading end of the assembly line is shown in Fig. 4; a trolley is seen on the return conveyor.

Five trolleys are used and these are loaded at two stations along the return conveyor. When a trolley is finally loaded, pneumatically-operated toggle clamps are brought into action by the manual application of a loose air line. The trolley is then dispatched on to the transfer truck and thereafter it is automatically controlled until it reaches the unloading station. All five welding presses are of identical design but the tooling is varied to cover the full welding programme. As is the case with the other presses in the welding shop, the tooling is removable and thus future model changes may be catered for. Each press control panel is interlocked in such a manner as to allow one machine only to weld at any given moment. The object of this is to limit the total electrical demand to manageable proportions. As at present adjusted, the underbody welding line is making 588 spot welds in its five presses. A spare trolley is held in readiness and is changed weekly so that all the trolleys are overhauled in rotation. A complete welding cycle in the heaviest loaded press can be made in approximately 40 seconds from the start to the return of the table.

From the welding-press line the underbody travels along a slat conveyor, where various brackets are welded on manually. It then proceeds to the main body-assembly area where all subsequent operations, to the final completion of the body, are performed manually.

A "Lumenated" ceiling is fitted in the gyro room at Elliott Brothers (London), Limited. This ceiling is supported by the original type of framework in lightweight steel, somewhat heavier than the aluminium track introduced recently.



The new aluminium track, which carries the corrugated rigid vinyl sheet forming a transparent ceiling, with aluminium suspension brackets and concealed track connectors. The transparent ceiling diffuses and integrates light from fluorescent or cold-cathode tubes suitably arranged above.

LIGHT-ALLOY FRAMEWORK FOR ILLUMINATED CEILINGS

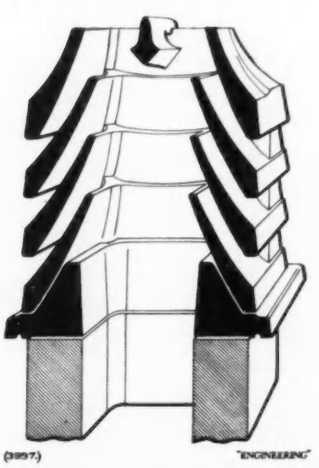
Some two years ago a new "integrating" lighting technique was introduced by Lumenated Ceilings, Limited, Alliance House, Caxton-street, London, S.W.1, designed to provide a uniform light from the whole ceiling area, with freedom from highlights and shadows and closely resembling natural daylight. Such a lighting system is of particular value in drawing offices and workshops where uneven lighting can seriously reduce working efficiency. The Lumenated ceiling consists of 3 ft. strips of corrugated rigid vinyl sheet supported in a lightweight metal framework suspended from the ceiling. Above the sheeting fluorescent or cold-cathode tubes—or even ordinary filament lamps—are arranged to give the desired intensity and colour of lighting.

Originally, the supporting framework was in lightweight steel. Recently, the company have introduced aluminium framing and components which, resulting in a reduction in weight of the Lumenated ceiling from 12 oz. to 5 oz. per sq. ft. will permit structural economies. The parts are shown in the illustration above. The attractive qualities of the new track's exposed soffit — which has a rippled or "fluted" pattern on its polished surface—greatly enhances the appearance of an installation, particularly as the width of the track is reduced to less than 2 in. The material used for the framework is 99 per cent. pure aluminium, which is highly resistant to tarnishing or corrosion.

The T-shaped junction plates formerly used to connect the framework track have now been replaced by concealed connectors, which allow the framework to be neatly mitred without screws. Continuous lengths of track can be similarly achieved and the corrugated translucent vinyl sheets are now retained in the framework by quick-sliding open track sections. By these means, the assembly and erection of a Lumenated ceiling has been greatly simplified, affording economy both in time and labour.

As well as providing a system of wall-to-wall lighting, the system can now be obtained in the form of single panels for suspension under individual fluorescent tubes or tungsten lamps, wherever localised lighting is desired.

Acoustic baffles which can be used in conjunction with a Lumenated ceiling without requiring additional ceiling space in the horizontal plane have also been introduced. The tops of these baffles are lipped so that they can be fitted into the flanges of a special aluminium track supplied in place of the normal framework.



The Supira chimney cowl has been designed to give a steady outflow of smoke whatever the direction of the wind.

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SMOKELESS CHIMNEY

At a recent demonstration in London, the advantages of a type of chimney cowl for eliminating downdraft and maintaining a constant suction were shown both by film and by practical example. The Supira cowl, as it is called, is available in this country through Omnia Constructions Limited, 121 London Wall, London, E.C.2. The principle is shown in the accompanying diagram.

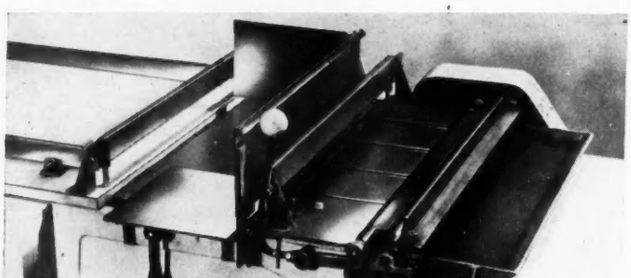
It consists of a base piece which stands on the normal stack, and on which rest three intermediate units and a crown unit, across which last is a deflector. With this arrangement, it was shown that smoke continued to pass out of the chimney, whatever direction the wind blew on it, even when blowing vertically downwards into the chimney. A suction gauge at the bottom of the chimney showed very little variation for varying angles of wind. The deflector is said to cause any rain falling into the chimney to be passed into the outgoing channels, so that it will not go down inside, and the base unit protects the stack from rain by its overhang and its throating. Chimney sweeping can be carried out using normal apparatus.

PARCELLING MACHINE

RAPID AUTOMATIC WRAPPING CYCLE

For kraft-wrapping, or over-wrapping with paper, parcels comprising cartons, boxes and bags capable of forming a firm unit load, the Spriggs parcelling machine, semi-automatic in operation, and hydraulically actuated, is now being marketed by Spicers Limited, 19 New Bridge-street, London, E.C.4. The Spriggs parcelling machine, shown in the illustration below was originally developed by the British Sugar Corporation for parcelling fourteen 2-lb. consumer packs in kraft paper wrapping; Spicers Limited, realising its potentialities for other industries, have acquired the sole distribution rights throughout the world.

The packets to be parcelled are marshalled by the operator in front of the loading platform on the machine. The operator draws a sheet of cut paper from a stack on one side of the machine, and places it on the loading platform against a stop so that its leading edge rests on a gummed roller. He then pushes the marshalled packets on to the loading platform, against a parcel guide and clamps them in position with a lever-operated flap in front of the loading platform. The operator then depresses a lever setting in motion the automatic wrapping cycle.



The loading platform of the Spriggs parcelling machine, with adjustable guides. Cut wrapping paper is stacked on the table on the left; the glue trough can be seen on the right.

The wrapping cycle is as follows: first, the loading platform is lowered by a vertical hydraulic ram, on which it is supported, so that the edges of the table fold the right and left-hand ends of the paper upwards. A second horizontal ram then moves inwards from the operator's right. Its upper edge folds the paper down over the top of the packets so that the gummed edge is uppermost. Hinged flaps on the ram head then swing inwards, making the first two side folds. The ram continues to advance and pushes the parcel under the left half of the table, which folds the other side of the paper down over the gummed edge. After being pushed between two bullnoses which complete the side folds and thus form the end flaps, the parcel enters the glue register, where glue is applied to both bottom end flaps. The drive of the applicator roller is linked with the horizontal ram and the roller itself has a special printer-profile, so that glue is applied only to the edges of the flap, giving a clean, secure parcel without wasting glue. Finally, the parcel is pushed past ploughs which fold down the top flap. To complete the parcel, hinged pressure plates fold the bottom flap upwards over the top flaps and hold them in place.

The last pair of pressure plates can be heated and thermostatically controlled to dry off the glue. This ensures that the parcel is securely sealed by the time it emerges from the machine. In the meantime, the ram returns to its starting position, allowing the loading platform to rise again. This cycle only takes 4 seconds.

Interesting points in the design are the provision of guides for every operation by the packer, the single control lever for lowering the load and initiating the packing cycle, the flexibility of the built-in electro-hydraulic system, the elimination of expensive gummed tape, the total enclosure for cleanliness and ease of operation, and the small overall floor area required (about 7 ft. by 3 ft. depending on the exact parcel size).

The machine is driven by a 2 h.p. electric motor, normally from a three-phase supply. The motor drives a pump mounted inside the hydraulic fluid tank, which has a capacity of 20 gallons.

The wrapping cycle is controlled by a series of solenoid-operated valves, which in turn are controlled by a cam. It is thus impossible for one operation to be initiated before the preceding one is completed. The quick-return movement of the rams is effected by feeding hydraulic fluid in front of the piston while allowing the fluid behind the piston to drain directly into the hydraulic reservoir.

The machine can be supplied in various sizes to suit different requirements. The standard model can accommodate parcels up to 17 in. by 12 in. by 7 in. deep, with some manual adjustment in every dimension. In addition, the hydraulic operation enables variations of up to $\frac{1}{4}$ in. to be taken up automatically without need for changing the adjustment. Even if this figure should be exceeded, the machine is not damaged, owing to the flexibility of the hydraulic system, which also ensures that the operator will not be injured even if his hand is caught between one of the rams and the parcel.

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HAPPIER SESSIONS IN THE DENTIST'S CHAIR

Turbo-Driven Dental Drill

A new high-speed dental drill, invented by a Swedish dentist, Dr. Ivar Norlen, has been developed for large-scale manufacture by Atlas Copco A.B., Stockholm, Sweden, and was introduced to the profession recently, demonstrated by Dr. Norlen, at the 30th Paris International Dental Session.

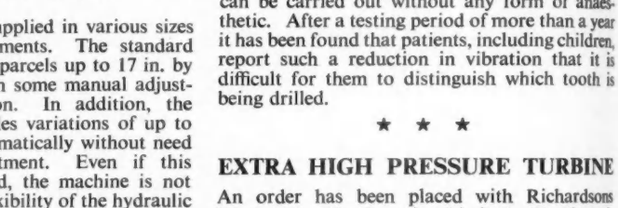
The Norlen drill operates at speeds up to 50,000 r.p.m. and requires only about one-thirtieth of the pressure which has to be applied by the dentist with conventional drilling equipment, which operates at speeds between 1,000 and 12,000 r.p.m. At such high speeds and low pressure full advantage can be taken of the diamond instruments and tungsten-carbide burrs which are now available. Vibration is greatly reduced and thus much of the discomfort is eliminated from the drilling operation.

The air-driven dental handpiece, shown in the accompanying illustration, is manually controlled. The elimination of the treadle and cord drive ensures more sensitive control, and has also a marked effect in reducing fatigue.

The equipment consists of a control unit, including a reducing valve, manometer and cut-off cocks and one straight and one contra-angle handpiece. The air turbine is built into the handpiece unit. Power is supplied by a reciprocating compressor which, with an air receiver of $1\frac{1}{2}$ cub. ft. capacity, is regulated automatically. When the pressure in the receiver reaches about eight atmospheres the motor cuts out. Current from an ordinary lighting circuit is sufficient to run the compressor.

A rubber tube carries air to the control unit whence it passes through a valve system and drives the turbine at a maximum speed of 140,000 r.p.m. A specially-designed reduction gear, fitted between the turbine and shaft, keeps the speed of the burr down to 50,000 r.p.m. A slight flow of air passes through the handpiece, cooling the bearings and preventing drillings and saliva from being drawn into it. The speed is controlled by a spring fitted to the outer casing of both straight and contra-angled handpieces. Light finger pressure on the spring releases the brake on the air turbine.

The combination of light pressure and high speeds provided by the air drill reduces frictional heat to such an extent that full crown operations can be carried out without any form of anaesthetic. After a testing period of more than a year it has been found that patients, including children, report such a reduction in vibration that it is difficult for them to distinguish which tooth is being drilled.



The Norlen dental drill operates at a high speed, up to 50,000 r.p.m., and low pressure, resulting in greatly reduced vibration and frictional heating.

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EXTRA HIGH PRESSURE TURBINE

An order has been placed with Richardsons Westgarth (Hartlepool), Limited, Hartlepool, Co. Durham, for what is believed to be the highest pressure steam turbine yet to be manufactured in Great Britain. The unit will be installed at the Margam "B" power station of the Steel Company of Wales, Limited, and will be built for a live steam pressure of 3,000 lb. per sq. in. gauge and temperature of 1,050 deg. F. The exhaust steam, after re-heating, will be discharged into the existing 600 lb. per sq. in. steam main. A maximum quantity of 240,000 lb. of steam per hour will be supplied from a Benson boiler and under these conditions an alternator output of 9,250 kW will be available for the steelworks. A special design of double-casing turbine will be adopted on account of the high pressure and temperature. The unit will be designed in conjunction with Brown, Boveri and Company, Limited.

MARKET RESEARCH COMES FIRST

The functions of market research as a tool of management in the engineering and metal industries are much the same as in other industries, but far less well understood. They are to assess demand, in terms of product design and quantities; to indicate the most efficient methods of sale, such as representation, agencies, distributors, publicity, advertising and other methods of taking the product to the user; to evaluate competition and its likely impact on a company's sales; and to interpret the needs of the market, even if only half expressed.

Market research is, in fact, a measuring instrument which should be highly sensitive and which should record its findings simply and clearly on a scale understood as easily by the designer and the production engineer as by the board of directors and the sales manager. But in some respects the techniques of market research in the field of capital goods differ from those in the field of consumer goods. One is normally dealing with a product which is complex and which is used in processes which can be even more complex. This means that the product, its design and construction and its variations from standard, must be understood by the researcher. Likewise the researcher should be so qualified technically that he can grasp the essential features of the product's applications, and he should have a background that enables him to talk the language of the designers and engineers from whom he has to seek information and opinion.

TECHNICAL WORK

Thus market research for capital goods tends to be " technical," in the sense explained above. A consequence of this—almost a corollary—is that the research work is more " qualitative " than " quantitive ": fewer people are interviewed than is common in consumer goods market research, the interviews last longer and are often with several people in each user firm, for example, the managing director, concerned with policy and aware of broad trends; the chief engineer, who is concerned if the product is to be incorporated in his designs; or the plant engineer if it is a capital item for use in the works; and the buyer, who has views on price and delivery. This does not mean that a knowledge of economics is unnecessary—on the contrary, no estimate of demand can be built up without an interpretation of economic data and a forecasting of business trends. There is less emphasis on statistical analysis, perhaps, than there is with wireless sets, tinned goods or bicycles, but an economist with good industrial experience is an essential member of a market research team. The emphasis throughout is on teamwork, with a combination of experience in administration, design, production, sales and economics. Few firms can provide this even when they have substantial market research departments. For the same reason, few market research consultants are able to tackle successfully research into capital goods markets. One of the functions of the Engineering Information Service established by this journal is to give skilled assistance and advice in this field.

The problems most frequently encountered by engineering companies which call for market research cover a very wide range, and are not easy to classify in a logical order. They include: launching a new product, taking up a manufacturing licence, location of a new factory, scale of output (tooling-up or new works), declining order books, low ratio of orders to inquiries, excessive variety, setting up a sales force, high cost of sales, low returns on advertising, changes in methods or channels of sales, investment in new fields, search for new products.

The question of new products, either developed by the company or added to the range through a licence arrangement, constitutes one of the most important headings under which technical market research is used in the engineering industries. Often companies spend large resources in the development of a product right through to the production stage with little more than shop tests and perhaps a few field tests. Market research should come first. The suitability of the product for the applications for which it is intended should be the subject of market tests. It can be technically admirable and yet be quite unacceptable, either because of price, prejudice (familiarly known as conservatism of users), or simply because it fails in certain respects, which can be minor and easily remedied to meet the needs of the market. In many cases it is not so new as the board may think.

Much money has likewise been lost through attempting to sell products—or processes—acquired from overseas under licence, because insufficient attention has been paid to local needs. The seemingly elementary mistakes made by the largest firms are sometimes very hard to understand. It has been said that market research into new product applications and demand can only be done by those who have been concerned with their development. Nothing, in our view, could be less appropriate: it is tantamount to asking an area sales manager to estimate demand in his area in order to work out a bonus system. Yet, clearly, only a highly qualified market research team can handle such a problem, which can involve the assessment of how far something quite new—and therefore about which there is neither knowledge nor experience—can replace the orthodox or can meet a need yet unexpressed. Another factor, of the greatest importance in all technical market research work, is the readiness of users to talk objectively to someone not intimately connected with the product or the company who made it. Even the largest companies experience difficulties in getting objective reactions to their research staff's inquiries. The advantage in this of the " independent " status of the consultant is considerable, and a major contribution to the quality of his work.

The location and size of a factory can have a most important bearing on the success of a company. Considerations such as availability of suitable labour, proximity of sources of raw materials and components, land values, etc., all play a part. Yet the market influences are great, and a well-chosen location from this viewpoint is often essential. The size of the plant which is put down, together with the scale of output for which tools are acquired, is one of the fields in which market research can make a vital contribution. One hears of a factory being erected in the Cotswolds because the managing director's wife enjoys living there, and of many factories built of a size which " appears reasonable." Such methods—if they can be so called—may work. But to have to extend a factory a year after it has been built, or to have unfilled square feet or idle machinery, can be very expensive. Engineering companies are now more frequently following the practice, long used in the field of consumer goods, of carrying out a systematic survey of demand for their products, upon which they base not only the size of their plant and the extent of their tooling but production schedules, the level of stocks (finished products) and long-term expansion schemes.

COMPETITIVE POSITION

Experience in the field of capital goods market research has shown that few companies carry out systematic analysis of their own sales data, and even fewer have any clear conception of the performance of their competitors. When a company's sales fall off steadily there is usually an inquest. Likewise when the ratio of orders to inquiries deteriorates. But there can be an increase in sales which yet hides a deteriorating competitive position. The ratio of orders to inquiries could improve if, for example, sales representatives became more selective in their approach work, but the firm may be getting a falling proportion of total inquiries put out for their products or services.

Market research, efficiently conducted, can provide most of, if not all, the information required to serve as a yardstick for the measurement of performance. One actual case will be sufficient to illustrate what can be obtained and its significance. A manufacturer of instruments wanted to find out if output could be expanded by 50 per cent. in five years in fields where profit margins were likely to ensure a worthwhile return for the investment in new plant. The market survey was carried out on the following lines:

(1) The company's sales were analysed, by user industries, by types of instruments and by principal customers. Close attention was paid to the average size of order, and to the amount of non-standard work taken on. The cost department prepared a detailed analysis of profitability on a sample of orders delivered over the last year of activities.

(2) The principal user industries were examined from the point of view of growth over a five-year period. All available published information was analysed and production curves plotted in each case. Later these were used to project the estimates of instrument sales based on the market investigation.

(3) All principal research organisations, Government and others, were visited and the company's designs were discussed in the light of new developments likely to emerge from research programmes.

(4) A number of companies using instruments in each industry were visited. The objects of the visit were to find out the scale of their purchases of instruments during one year and projected purchases over a longer period. Normally, this information was obtained by type and make, and the reasons ascertained for buying a particular make. This proved invaluable as a guide to the " technical " standing of various suppliers, including that of the company concerned in the survey, and threw a strong light on matters which affect the sales organisation—prices, effectiveness of trade literature and instruction manuals, quality of service, impact of advertising, effectiveness of representation and many other factors. Questions were asked on the need for non-standard products, answers to which proved that a great deal of scope existed for selling " what the company makes " rather than " what the customer thinks he wants."

(5) Export information was extracted from statistical and other British sources. The trade publications of all principal foreign competitors were obtained.

The analysis of the information obtained from the field work yielded a most comprehensive picture of the instrument business. How this was used by the management will be discussed in a later article. It suffices to say at this point that it had a major impact, not only on the company's marketing policy but also on their design policy. The cost per inquiry was substantially lowered and the ratio of orders to inquiries was increased. The deductions which were made from the information helped to simplify the company's range of products, by concentrating on the more profitable items. The variety of designs was reduced through issuing instructions to the sales force to sell the company's standard products whenever possible.

Technical market research of the type described in this article is substantially more expensive on a time basis than market research for consumer goods. The reason for this is that the staff needed to carry it out must be of a level adequate for interviews with heads of firms and have first-class industrial background and technical knowledge. But since the numbers of interviews are normally very much smaller than in the case of consumer goods research, the total cost is often lower. The scope of the survey is the main factor to consider, and this can vary within wide limits. But in this as in other fields of consultancy the cost is not the main item to consider. The test of its value is its effect on the cost per unit sale and on the cost of production through the simplification of design.

ROLLING MILL CONTROL

INSTRUMENTS AND RESEARCH AID PRODUCTION

The modern rolling mill is a highly developed production machine governed by a precise system of operations, and it is the aim of steelworks engineers to improve still further upon this technique and rely less and less on the human element. This is quite clear from the first four papers presented for joint discussion on the first day of the autumn general meeting of the Iron and Steel Institute, held in London on November 21 and 22.

In the first paper, on " Recording Techniques for Rolling-Mill Operation Studies," Mr. E. A. Chard, Mr. W. W. Hastings and Mr. D. F. Nettell, of the Plant Engineering Division of the British Iron and Steel Research Association, recommended the adoption of a modified teleprinter perforator and a 12 channel recording oscillograph to provide a continuous record of information, so as to eliminate human errors due to the participation of a number of observers who might be liable to fatigue. The authors stated that the use of tape perforators for recording data automatically, in a form which lent itself to rapid analysis, had been fully developed by one of them (Mr. D. F. Nettell).

CONTINUOUS RECORDS

Characters representing letters, numerals or symbols were punched in a paper tape by a perforator controlled from a keyboard, and as holes could be punched in five parallel tracks on the tape, any character could be represented in a code by the arrangement of holes and blank spaces in a line across the width of the tape. An additional row of small holes in the tape was provided for engagement with the feed sprocket. For recording data electrically, the keyboard control was inconvenient and a teleprinter had been modified for the purpose.

The punching mechanism was operated by a camshaft driven by a small electric motor and the speed of the camshaft and the tape feed sprocket were controlled by a relay-operated trip mechanism. The rate of perforation of the tape depended on the rate at which the impulses were transmitted to the relay on the trip mechanism. A time-base unit was therefore used which could be set to give any required impulse frequency.

Examples of the operations which might be recorded using the five available tracks included the time spent by an ingot in the main rolls, the screwdown movement, the operating time of the manipulator, the operating time of the tilting fingers and the speed of the roller tables.

The 12 channel recording oscillograph was a commercial instrument, designed primarily for use in conjunction with strain-gauge equipment, but any event or variable which could be translated into a current could be equally well recorded.

The two instruments were complementary; the tape perforator was useful for recording over protracted periods and the 12 channel recorder had the advantage of high speed of response and the ability to record directly-variable quantities.

The application of the teleprinter equipment to a high-lift reversing slabbing rolling mill at the Abbey Works of the Steel Company of Wales, Limited, was described by Mr. H. G. Jones, Mr. D. T. Steer and Mr. P. D. Dickerson in the second paper, entitled " The Time Characteristics of the Slabbing Mill." The authors stated that the channels on the teleprinter tape had been used to record the time the ingot was in contact with the rolls, the rolling-mill screw-up and screw-down times, the manipulation time, and the time the tilting-finger lifts were operated. Records had been obtained for about 400 ingots described by the rolling-mill operators as being of " satisfactory heat." It had been ascertained that useful work on the ingot, namely, the time it was in contact with the rolls, only occurred for 35 per cent. of the total time taken for the rolling process. The single most time-consuming operation was tilting and its associated operations. A universal mill having a set of vertical rolls just in front of the horizontal rolls, could be installed to reduce the number of tilts, and also, by stopping the spread on the vertical sides of the ingot, would save about two passes per ingot. With the slab used, it was estimated that a universal mill would reduce the rolling time by at least 11 per cent.

Mr. Jones, Mr. Dickerson and Mr. Steer were also the authors of the third paper which dealt with the " Principles Governing the Design of Ingots for High Output in the Slabbing Mill." They found that the output from a slabbing rolling mill producing a given range of slabs could be increased by using thicker ingots. The width of the ingots had virtually no effect on the tonnage rolled, provided that no extra tilts were involved. An increase in height of the ingot, particularly at the expense of the width, also increased the output.

The fourth and last paper on rolling-mill operation was by Mr. H. H. Ascough, rolling-mill superintendent at the Abbey Works of the Steel Company of Wales, Limited. It was entitled: " Maximum Utilisation and Problems of Wide-Strip Rolling and Sheet-Finishing Equipment " and described the system of operating the 45 in. slabbing mill and the 80 in. hot and cold strip mills of the Steel Company of Wales.

The author stated that one of the most difficult problems in planning the layout of high-production rolling mills, comprising a sequence of many different units, was to maintain a balance of outputs between them. Thus, if the potential output per week of a three-stand cold-reduction mill were 15,000 tons and the output of a pickle line serving the mill 20,000 tons, there was a utilisation loss of pickle-line output of 5,000 tons. Again, soaking-pit throughput was related in some measure to the prompt stripping, charging and drawing of ingots, and three ingot-charging cranes, together with three stripping cranes were necessary for steel outputs of over 40,000 tons a week.

UNEQUAL FEEDING

While mechanical and electrical breakdowns were troublesome on most mills, the unequal feeding of the slabbing mill with hot ingots and the time spent out of the rolls were the prime causes of a modern slabbing mill failing to sustain the rolling rates. A well designed slabbing mill such as that at Abbey was not difficult to maintain and, apart from major breakdowns due to accidents, lost time had been confined to wear on the screws, the failure of feed-roller drives, and the stretching of holding-down bolts in the table rollers.

The greatest influence on the output of the hot strip mill was the availability of the slab furnaces and this availability was largely a problem of refractories, but it was also affected by the avoidance of slag, the removal of which required the furnace to be idle.

The hot strip mill schedule was the commercial and technical programme upon which the output and, to some extent, the quality, were based. There was an urgent need for a fully-automatic method of gauge control and the introduction of loadmeters into mills for measuring roll force was yielding considerable data. While X-ray meters were used for the continuous measurement of gauge, current experiences with loadmeters measuring roll-separating force, might enable screw-downs to be automatically adjusted to the correct gauge. With sufficient heating capacity and reasonable schedules, a modern 80 in. strip mill could process upwards of 50,000 tons a week.

The production of good shape over a range of widths in the 80 in. three-stand cold-reduction rolling mills at the Abbey Works called for the judicious use of roll crowns and the application of a roll-cooling medium in controlling the heat generated from rolling friction and plastic deformation. The medium used at the Abbey Works consisted of mineral oil and water and it had been found ineffective to increase the concentration much above 1½ per cent. The volume of liquid in circulation was approximately 1,200 gallons per minute with an 8 deg. F. rise in temperature. Prompt dispatch of finished material was essential not only for the sake of good organisation but also in view of the phenomenon of ageing of tempered rimming-steel sheets.

The joint discussion on the four papers which ensued, was on the whole, not controversial, and most of the speakers emphasised and amplified many points raised by the authors. Thus, it was thought that Mr. Ascough had given a timely reminder to plant manufacturers that after they had supplied their equipment, there still remained the very considerable management problem of controlling the flow of materials in such a manner as to ensure that all the equipment provided was utilised properly and to its maximum efficiency.

A question as to whether shot-blasting apparatus had been tried by the Steel Company of Wales, as an alternative or as a supplement to acid pickling, met with the reply that one firm in the United States had tried this but, apparently, without very much success, as they did not recommend it.

AUTOMATIC SCREWDOWN SCHEDULING

Some reference was made to time-study techniques and one of the conclusions drawn from tests carried out in one works was that an improvement in screwdown control was the main factor which could improve existing rolling-mill output, possibly with the adoption of automatic screwdown scheduling.

In this connection it was announced that the screwdown remote-position control drive installed by Colvilles Limited, to a scheme suggested by the British Iron and Steel Research Association, had been in operation for approximately three weeks. It was well liked by the operators, who did not want to go back to the old methods, and the firm were seriously considering putting remote-position control of the screwdown gear in all the rolling mills under their control.

Emphasis was laid on the fact that, whereas some hundreds of thousands of pounds had been spent on the production instrumentation of steel melting shops in this country, the oscillography equipment of the research and development departments was generally inadequate. It was pointed out that the 12 channel oscillograph described in the first paper was an extremely versatile instrument. It was a standard piece of apparatus and easily used and, when taken into a rolling-mill shop, it could be put to work in all 12 channels in a very short time. Since the paper had been written and as a result of work carried out by the British Iron and Steel Research Association on the tape perforator described, which was capable of printing up to ten characters a second, a new instrument had been developed, which was giving from 25 to 30 perforations a second. It was now readily available as a standard instrument.

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CURRENT LIMITING REACTORS

Nine current limiting reactors have recently been supplied by the British Thomson Houston Company, Limited, Rugby, to Gemeentelijk Electriciteits Bedrijf, Holland. These reactors are unusual in that the incoming and outgoing connections are supported from the reactor itself instead of from the walls of the reactor cells. Their rating is for 6 kV for 5 per cent. on loads of 2·6 MVA.

ATOMIC REVIEW

Western Approaches

The state of the U.S. atomic energy programme—Vessel for the Shippingport pressurised-water reactor—Oil-fired superheater for nuclear plant—Study for heavy-water power reactor—development of small gas-cooled reactors—Company to make fuel elements—Reactors for research, therapy and export—U.S.A.E.C. London office—Formation of nuclear energy trade association.

From time to time during the next few weeks Atomic Reviews will be devoted primarily to developments abroad. We hope in this way to remedy our neglect of overseas news in recent months when important events in Britain have monopolisd our attention. We began last week by discussing some American package plants. We shall continue to report major items of home news.

Possible Expansion of U.S. Programme

According to the American periodical, *Business Week*, the completion of the Calder Hall atomic power plant has set off a big reaction in the United States. Leadership in the atomic field is believed by many to have passed to Britain. The original United Kingdom programme aimed at 2,000 MW installed capacity by 1965, though it is now likely to be considerably greater, perhaps more than double; the Russians are said to be planning a total capacity of nearly 2,500 MW by 1960; and the United States 800 MW by 1960 and 1,200 to 1,300 MW by 1965. It should be borne in mind, however, that United States requirements are very different from our own. The American programme allows for the completion of six large plants by private industry by 1960 and three more during the following five years, as indicated in the table on page 762. A number of smaller plants are also proposed, as for example the Chucagh Electric Association's 10 MW sodium-cooled heavy-water moderated plant for Anchorage, Alaska, and the 12·5 MW organic-moderated reactor (using the hydrocarbon terphanyl) proposed for Piqua, Ohio. This reactor would use slightly enriched uranium as fuel and development work would be carried out by North American Aviation. Reference has also been made to a boiling-water reactor plant with separately fired superheater for Pasadena, California. Senator Albert Gore has renewed his pressure on the Atomic Energy Commission to build six large plants, and, though so far he has been unsuccessful, it appears that private industry, before January 1, will propose construction of two, three or four more large-scale (over 50 MW capacity) atomic power plants. Mr. Lewis L. Strauss, chairman of the U.S.A.E.C., has said that the total number of reactors so far built in the United States is 82, with 127 more either under construction or planned. This figure (209 in all) is a considerable advance on that obtained from another source and published in Atomic Review last week. The total number of private power plants so far projected including small plants is said to be 16 with 13 others envisaged. There are also 10 experimental plants planned by the U.S.A.E.C. yielding a total, including the 60 MW from the Shippingport station, of 90 MW.

Shippingport Reactor

The first of the American nuclear stations to be completed will be that at Shippingport, Pennsylvania. Two items of news concerning it have recently been reported: first, the reactor pressure vessel has now been completed, and second, a similar plant, though of only 11·5 MW, is to be built by the Westinghouse International Electric Corporation (the main contractors for the Shippingport project) for erection in Belgium. This station is to be completed by 1958. The electrical output of the American plant is to be 60 MW, though generating machinery will be such as to allow later extension to 100 MW.

The Shippingport pressure vessel, which has been made by Combustion Engineering Incorporated at their Chattanooga works in Tennessee, weighs 235 tons including the removable head, and can withstand a pressure of 2,500 lb. per sq. in. at 600 deg. F. (316 deg. C.). It is shown in Fig. 1. At rated load 26 million lb. of primary coolant water will circulate through the vessel per hour, entering by four inlet nozzles and passing through the core, where the temperature will be raised from 507 deg. F. (264 deg. C.) to 542 deg. F. (283 deg. C.). The vessel will contain thermal shields, a core assembly and other equipment weighing 100 tons making a total of 335 tons in all. The internal diameter is 9 ft. 1 in. and the interior height 31 ft. 3 in. The removable upper head, which weighs 85 tons and is shown in Fig. 2, is fastened to the shell section by 42 studs 6 in. in diameter (Fig. 3), each 80½ in. long and together with the nut weighing 700 lb. These studs are elongated by heating before placing in position, so that on contraction, after the nuts have been turned through a predetermined angle, the tension in the studs (40,000 lb. per sq. in.) is sufficient to maintain correct mating of the two parts of the vessel. Since the hot primary coolant water passing through the reactor vessel is corrosive, the internal parts are clad with stainless steel of ¼ in. minimum thickness, while the hemispherical bottom head and shell courses were fabricated from manganese-molybdenum clad plate of 6 in. and 8¾ in. minimum thickness respectively. The base material of the vessel is a steel with a minimum tensile strength of 80,000 lb. per sq. in. and having the composition: manganese 1·10 to 1·50, molybdenum 0·40 to 0·60 and carbon 0·27 maximum (ASME SA-302, grade B). The stainless cladding is of an 18/8 steel with 0·03 per cent. minimum of carbon (AISI 304-L). To remove the heat generated in the thermal shields, 15 per cent. of the primary coolant flow is directed up along the shields and vessel walls before passing through the core. A flow baffle attached to the lower portion of the shields distributes the flow evenly across the diameter of the core. Two quarter-scale steel models have been tested, and a full-diameter test vessel is also to be built.

Reactor Plant Superheater

The oil-fired superheater for the nuclear power plant to be built at Indian Point, New York, is to be made in two sections, each handling 1,075,000 lb. of steam per hour, raising it from 450 deg. F. (232 deg. C.) to an outlet temperature of 1,000 deg. F. (538 deg. C.). The superheater

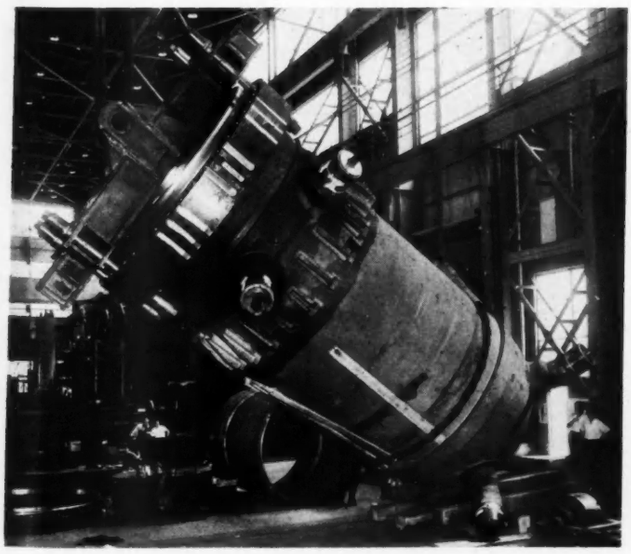
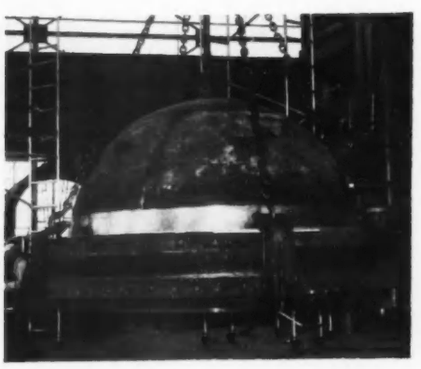


Fig. 1 (left) Shell of the reactor vessel built by Combustion Engineering, Inc., for America's first full-scale nuclear power plant at Shippingport, Pa. The reactor is of pressurised-water design.

Fig. 2 (right) The 85 ton removable head for the Shippingport reactor vessel will have 46 openings for fuel-handling equipment, instrument leads and control rods.

Fig. 3 One of 42 bolts for securing the head (below) to main part of Shippingport reactor vessel.



will be constructed by the Foster Wheeler Corporation.

Heavy Water Power Study

A design study and development work to determine the feasibility and economics of heavy-water moderated reactors for power generation will be undertaken for the U.S.A.E.C. by E. I. du Pont de Nemours and Company. The study will pay special attention to the utilisation of natural uranium as fuel. The work will be performed under an existing contract between the company and the Commission for the operation of the A.E.C's Savannah River plant in South Carolina. The agreement makes no commitment for construction of a power reactor.

Gas-Cooled Reactor Experiment

The U.S.A.E.C. has begun contract negotiations with the Aerojet-General Corporation, of Azusa, California, for the design, fabrication and operation of a gas-cooled reactor experiment at the National Reactor Testing Station, Idaho.

Reactors for Research and Export

An atomic reactor said to be small enough to be operated by one man and costing 55,000 dols. has been produced by the Atomics International Division of the North American Aviation Company in California. It is 8 ft. high and 8 ft. in diameter and can be put into operation at a chosen site within six months. It has been designed for schools, industrial plants and medical laboratories.

The use of nuclear reactors directly (instead of simply as sources of radioactive isotopes) for medical purposes is under investigation in America. At the University of California School of Medicine a reactor has been built which is specially designed to provide radiation for cancer research and treatment. The reactor core, which is shown in Fig. 5, is contained in a stainless-steel sphere and comprises four gallons of highly enriched uranyl sulphate solution. The core is designed to emit gamma rays and thermal neutrons, both of which can be used in treating cancerous tissues and malignant growths.

A 5 MW swimming pool research reactor has been ordered from the Babcock and Wilcox Company of New York by the National Research Council of Brazil. It is to be operated by the Atomic Energy Institute at the University of Sao Paulo, and will be similar to one at the University of Michigan, shown under construction in Fig. 4. Other research reactors being built by American firms for overseas users include a 3 MW swimming pool reactor for Spain (General Electric); a 5 MW pool reactor, similar to one at Livermore, California, for Denmark (Foster-Wheeler); a 50 kW reactor fueled with an aqueous solution of uranyl sulphate, similar to one at the Armour Research Foundation in Chicago, for Japan (North American Aviation); a 20 MW modified pool reactor costing some two million dols. for Holland (American Car and Foundry Industries); a 5 MW heavy-water reactor similar to CP-5 at the Argonne National Laboratory for Italy (American Car and Foundry Industries); and two swimming pool reactors, one costing 450,000 dols., for Germany (AMF Atomics and Babcock and Wilcox). In addition, AMF Atomics is to design and build a swimming pool reactor for McMaster University, Hamilton, Ontario, to operate by 1958. It was also announced last month that a licence had been granted for exporting the Japanese reactor, which would be the first transaction of its kind completed by the American atomic energy industry.

Fig. 4 (left) University of Michigan 5 MW swimming-pool research reactor under construction. A similar reactor is being built for the National Research Council of Brazil.

Fig. 5 (right) The stainless-steel core tank of the University of California medical reactor contains a solution of enriched uranyl sulphate, which provides radiation for the direct treatment of cancer.

The experiment is intended to develop engineering data and experience for the design and construction of military package power reactors and small civilian central station plants.

Fuel Element Production

Sylvania Electric Products and the Corning Glass Works of America have formed a new company, Sylvania-Corning Nuclear Corporation, to specialise in the production of fuel elements for nuclear reactors.

It has been shown that boron can capture thermal neutrons and produce a nuclear reaction inside a cancer so creating alpha particles which destroy the malignant cells; safety of healthy tissues is ensured by the short range of the alpha particles. This solution-type reactor operates at a power level of 5 kW with a maximum power of 50 kW, and has been built by North American Aviation Incorporated. The arrangement of the core was shown on page 571 of the November 2 issue of ENGINEERING.

TABLE. LARGE COMMERCIAL NUCLEAR POWER PLANTS UNDER CONSTRUCTION OR PLANNED IN THE UNITED STATES

Name or Site	Shipping-port, Pa.	Hellum, Neb.	Rowe, Mass.	Monroe, Mich. ("Enrico Fermi")	Dresden, Ill.	Indian Pt., N.Y.	Eastern Pennsylvania	Florida	Virginia, Carolina
Date complete	1957	1959	1960	1960	1960	1960	1962	1962	—
Type	Pressurised water	Sodium graphite	Pressurised water	Fast breeder	Dual-Cycle Boiling water	Pressurised water (Th-U converter) plus oil superheater	Aqueous homogeneous	Bismuth graphite	—
Capacity (MW electricity)	65	75	134	100	180	236 (96 from nonnuclear sources)	150	200	—
Builder and designer	U.S.A.E.C. and Westinghouse Electric Corporation	Atomics International (North American Aviation)	Westinghouse Electric Corporation	Atomic Power Development Associates	General Electric Company	Babcock & Wilcox Company	Westinghouse Electric Corporation	Babcock and Wilcox Allis-Chalmers	—
Operator	Duquesne Light Co.	Consumers Public Power District	Yankee Atomic Electric Co.	Power Reactor Development (Detroit Edison Co.)	Commonwealth Edison Co.	Consolidated Edison Co.	Pennsylvania Power and Light Co.	Florida Utilities Group	Virginia Carolina Utilities Group
Running total (installed MW)	65	140	274	374	554	790	940	1,140	—

A.E.C. in London

The United States Atomic Energy Commission has now established liaison offices in London and Paris. Dr. E. L. Brady, formerly of Knolls Atomic Power Laboratory, Schenectady, has taken up the post in London. An A.E.C. liaison office has been in operation at Chalk River, Ontario, Canada, for some time.

HOME NEWS

Nuclear Trade Association

In order to establish a permanent means of liaison between manufacturers on matters relating to nuclear energy and associated developments the Nuclear Energy Trade Associations' Conference (N.E.T.A.C.) has been formed. The founder members of N.E.T.A.C. are: the British Chemical Plant Manufacturers' Association, the British Electrical and Allied Manufacturers' Association, the British Engineers' Association, the Scientific Instrument Manufacturers' Association and the Water-Tube Boilermakers' Association. Membership, which in no way restricts the autonomy of the participants, is open to those trade associations concerned with nuclear energy equipment. N.E.T.A.C. has already initiated action to make better known overseas the achievements of British nuclear industry. The chairman at present is Mr. W. K. G. Allen, and the address of the new organisation is 32 Victoria-street, London, S.W.1.

In Parliament

OUR NEGLECTED WATERWAYS

Sandwiched between matters relating to Egypt and other acute political problems, a considerable amount of attention has been given during recent sittings in the House of Commons to questions concerning British industry and transport.

For example, complaints were made by Mr. W. Hannan (Labour) about the delay in the issue of a report by the Committee of Inquiry on Inland Waterways and Canals, which the Minister of Transport and Civil Aviation had appointed last February. He pointed out that, when the Minister made his original statement in the House and replied to criticisms that the appointment of the Committee was a delaying tactic, the Minister had said that the need was for the Committee to report quickly and objectively. What was the interpretation put upon the word "quickly"? Did it, Mr. Hannan asked, mean one year, or two years, or five years?

Mr. Hugh Molson, Joint Parliamentary Secretary to the Ministry, said that the Committee was understood to be making steady progress and the Government was anxious to have its report as soon as possible, but he could not say when that would be. Inquiries had been made as to the delay and it was understood that a good deal of the written evidence, asked for as long ago as last April, had not yet been received.

The suggestion that there was really no object in having a committee at all, when the whole of the facts were known, was put forward by Mr. G. R. Strauss (Labour). Some sections of the canal system at Openshaw, Manchester, were in such a dilapidated state, according to Mr. W. R. Williams (Labour), that they constituted a serious menace to life and health. His proposal that the Committee should be requested to make an interim report was turned down by Mr. Molson, who said that his Ministry would certainly not ask for such a report.

Mr. Humphrey Atkins (Conservative) wanted the Minister of Transport to issue a general direction to the British Transport Commission to make the greatest possible use of their fleet of vessels on the canals and waterways, in view of the fact that goods could be carried by water with a considerably smaller expenditure of oil per ton-mile than by road. Dealing with this aspect of the canal situation, Mr. Harold Watkinson, the Minister, said that there was no need for such a direction. The Commission had informed representatives of trade and industry that there was spare capacity on the services provided by their craft and that they would do their utmost to cater for traffic offered for conveyance by inland waterways.

PROGRESS IN ATOMIC ENERGY

A number of questions were put respecting recent developments in connection with the supply of atomic energy. In answer to Mr. William Warbey (Labour), who asked about the prospective completion dates for the Calder Hall No. 2 unit and for the two units under construction at Chapel Cross, Mr. R. A. Butler, the Lord Privy Seal, said that the United Kingdom Atomic Energy Authority expected that the second unit at Calder Hall would be completed in the autumn of 1958. The two units at Chapel Cross were expected to be completed during the following year.

Mr. Warbey commented that this remarkable rate of progress showed what might be accomplished in the civil construction of atomic power stations if similar priority and urgency were given to them. He asked that such urgency should be given to construction work of that kind, in view of the great need that existed to replace Britain's oil supplies. The Government, Mr. Butler said, were in fact giving urgent attention to that matter. He told Mr. Roy Mason (Labour), who asked that the Government should give consideration to the building of atomic energy package stations, that the Authority was examining a number of advanced reactor systems. Some of these might be particularly suitable for development on a small scale, but none of them was likely to reach the stage of commercial use for some time to come.

A question by Mr. F. T. Willey (Labour) to the Chancellor of the Exchequer, was answered by Mr. Henry Brooke, the Fianancial Secretary to the Treasury, who said that the Government were considering a proposal for the establishment of a national research centre for nuclear physics, but that he was not yet in a position to make a statement.

SOVIET TECHNICAL LITERATURE

Information was sought by Mr. F. T. Willey as to what particular steps the Department of Scientific and Industrial Research took to provide a collection of Soviet scientific and technical literature. Replying on behalf of the Lord President of the Council, Mr. J. R. Bevins, the Parliamentary Secretary to the Ministry of Works, said that the Department had been collecting Russian scientific and technical literature for some years and that this material had been available to interested persons. The Department had now decided that they would set up a section to deal exclusively with this matter.

Mr. Willey also asked for information about the projects for the National Science Reference and Lending Libraries. Mr. Bevins told him that, as stated in the ninth annual report of the Advisory Council on Scientific Policy, the Department had been given responsibility for the National Science Lending Library and were making a start with the work involved.

LARGER TANKERS WANTED

It was thought by Mr. Philips Price (Labour) that, in consequence of the stoppage of oil supplies from the Middle East, the Government should take steps to encourage the construction of large oil tankers for the conveyance of oil by the Cape route. Mr. Maurice Edelman (Labour) wanted the Minister of Transport to introduce legislation to allow him to enter into contracts for the construction of super-tankers. Mr. C. F. H. Gough (Conservative) felt that the desires of the shipping industry to build large tankers were being retarded by financial considerations and hoped that the banks and insurance companies would be encouraged to provide the capital sums required.

The construction of tankers, Mr. Watkinson said, was the responsibility of the shipping industry. Several companies, in fact, were placing orders for very large tankers: a development which he cordially welcomed. The building of these vessels was a lengthy task and no tanker which was not under construction at the present time could make any rapid or early contribution towards meeting the country's present difficulties.

He told Commander J. F. W. Maitland (Conservative) that his Ministry had recently been in touch with the oil companies and port authorities regarding their proposals to facilitate the increased use of large tankers. Schemes for providing reception facilities for such vessels were in hand, or under examination, in the Thames, Southampton Water, the Mersey, the Clyde, and at Milford Haven. Consideration had now to be given to making facilities available for tankers of 60,000 tonnage, or even greater. Those arrangements were in hand.

SHIPOWNERS' LIABILITIES

H.M. Government are anxious that the international conference to consider the draft convention of the International Maritime Committee, relating to the limitation of the liability of owners of shipping, should take place as soon as possible. According to an answer by Mr. John Profumo, Joint Parliamentary Secretary to the Ministry of Transport, to Mr. S. Knox Cunningham (Ulster Unionist), it is hoped that the conference will be held next year, and inquiries have been made of the Belgian Government, who are responsible for convening the meeting, as to how soon it can take place.

The Minister was then asked if he were aware of the opposition which existed in the United Kingdom to the retention of any statutory right of the owners of vessels to limit their liabilities when claims were brought in respect of personal injuries or loss of life. Mr. Profumo said that he was aware that there were differing opinions on this subject, which made it all the more important to secure international agreement. The liabilities of shipowners for personal injuries or loss of life were covered by the draft convention to which reference had been made. Accordingly, the prior introduction of legislation, as had been suggested, would be inappropriate.

Steel for Shipbuilding

Asked by Mr. Willey what steps were being taken to improve the supplies of steel to British shipyards, Mr. S. Wingfield Digby, the Civil Lord of the Admiralty, said that the First Lord had had further consultations with the President of the Board of Trade and with the chairman of the Steel Board on that subject. Further, the First Lord had received a deputation from the shipbuilding, ship-repairing and marine-engineering industries on November 30, when problems relating to deliveries of steel were fully discussed.

Mineral Processing Laboratory

In another question, Mr. Willey asked for information as to what progress was being made in connection with the proposals for the formation of a central mineral processing laboratory. He was informed by Mr. Bevins that, as stated in the ninth annual report of the Advisory Council on Scientific Policy, the D.S.I.R. were at present discussing, with the principal scientific and industrial interests concerned, the possibility of establishing such a laboratory.

Staggering Working Hours

A plea to the Minister of Transport that he should try to persuade firms to stagger their hours of work, so as to ease the pressure on public transport during the rush hours, was put forward by Mr. John Parker (Labour). Mr. Harold Watkinson told him that, earlier this year, the Transport Users' Consultative Committee for London had made some progress respecting pilot schemes for selected zones. In association with his Ministry, the Committee had also helped to promote the staggering of hours at Government offices. He had now appealed to the public for a further special effort and, as a matter of urgency, the newly-appointed Committee were inviting about 2,000 of the larger employing organisations in the area to co-operate.

Outside London, the chairmen of the Regional Boards for Industry were being invited to initiate suitable measures.

One-Way at London's Bridges

Mr. Hugh Molson informed Mr. A. E. Cooper (Conservative) that, with the approval of the Minister, the Commissioners of Police were ready to undertake an experiment in one-way working at the northern approaches to Tower Bridge, as soon as section 36 of the Road Traffic Act, 1956, was brought into force. Discussions respecting the situation at London Bridge, and in regard to the southern approaches at Tower Bridge, were still in progress.

Reorganising Electricity Supply

Matters respecting the reorganisation of the electricity supply industry were raised by Mr. A. M. F. Palmer (Labour/Co-operative). He wanted to know what consultations had taken place on this subject between the Minister of Fuel and Power and the Central Electricity Authority.

Mr. Aubrey Jones replied that he had had discussions with the chairman and two deputy-chairmen of that Authority and with all the chairmen of the Area Boards. In formulating the proposals which had been laid before Parliament, full account had been taken of their views upon the reorganisation of the industry.

POCKET HARDNESS TESTER

A miniature hardness tester, the Sklerograf, which operates on the rebound principle, is now available in this country through the agency of C. Tennant, Sons and Company, Limited, 4 Copthall-avenue, London, E.C.2. It is shown in the accompanying illustration.

When used, the Sklerograf is placed in a vertical position on top of the specimen to be tested and a rebounding bar, which carries a hardened steel ball point, is raised until held in place by a locking device. When this is released by pressing a catch, the bar falls and rebounds to a point corresponding to the hardness of the object, where it is retained. The makers state that hardness can then be read to within 1 point Rockwell C, by noting the position of the indicator ring on the hardness bar against the graduated scale. Conversion tables give the equivalent Shore, Rockwell C, Rockwell B or Brinell hardness scale readings.

Spot checks of the hardness of materials can be made by the pocket-size Sklerograf which operates on the rebound principle

Objects weighing 4 lb. or more require no special provision for testing. Smaller objects, such as small machine parts, tools and sheets, should be placed on a steel block or anvil so as to provide sufficient mass, and a special anvil for this purpose is available. For testing cylindrical forms of from 4 in. to 16 in. or from 16 in. to 24 in. in diameter, a prismatic stand with water level can be provided. The Sklerograf is supplied in a nylon-reinforced rubber case, 7¼ in. long by 1 in. diameter; the instrument and container weigh only 9 oz. and can easily be carried in a pocket.

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GLYCERINE AND ITS USES

Apart from its uses in the explosives and pharmaceutical industries, the main applications of glycerine are in the paper, printing, dyestuffs-manufacture, chemical-manufacture, textile, adhesive and gelatin, and rubber industries. It is also employed in the production of de-icing and anti-freeze materials, household cleaners, and soaps and detergents.

In the course of an address delivered in London on November 27, Mr. R. E. Huffam, chairman of the United Kingdom Glycerine Producers Association, Limited, 43 Portman-square, London, W.1, stated that after a period of short supply during and after the war of 1939-45, glycerine was now in abundant supply. Consequently, the Association were formulating plans to ensure that the full potentialities and advantages of glycerine and its derivatives were made known to all users and potential users.

One of the ways to be adopted was by publishing, beginning in January, 1957, a periodic bulletin, entitled "Glycerine Facts." This would be made available, on request, to trade and technical publications. Meanwhile, free copies of a new booklet entitled "Glycerine, 1,500 Ways to Use It," were obtainable on application to the Association.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"In Search of Coal, with Particular Reference to Undersea Reserves," by W. H. Brooks. E.L.M.A. Lighting Service Bureau, 2 Savoy-hill, W.C.2. Tues., Dec. 18, 6.30 p.m.*

NOTTINGHAM
American Industrial Films. Nottingham Branch. Offices of the East Midlands Electricity Board, Smithy-row, Nottingham. Wed., Dec. 19, 7.30 p.m.

British Interplanetary Society

LONDON
"Astronomy and Earth Satellites," by Dr. Michael W. Ovenden. Caxton Hall, off Victoria-street, S.W.1. Sat., Jan. 5, 6 p.m.

British Kinematograph Society

LONDON
"Economics of Film Washing," by Dr. G. I. P. Levenson. Film Production Division. Royal Society of Arts, John Adam-street, W.C.2. Wed., Dec. 19, 7.30 p.m.

Building Centre

LONDON
Documentary Films on "The Festival of Britain." Wed., Dec. 19, 12.45 p.m.

Diesel Engineers and Users Association

LONDON
"Report on Heavy Oil Engine Working Costs and Performance 1955," and an Informal Discussion on "Operating Problems." Caxton Hall, off Victoria-street, S.W.1. Thurs., Dec. 20, 2.30 p.m.

Illuminating Engineering Society

BIRMINGHAM
Display of Lighting Fittings. Birmingham Centre. Birmingham College of Technology, Suffolk-street, Birmingham. Tues., Jan. 1, 6 p.m.

LIVERPOOL
Various short papers on "Interesting Lighting Installations." Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Tues., Dec. 18, 6 p.m.

MANCHESTER
"Colour Matching," by A. Wilcock. Manchester Centre. Offices of the North-Western Electricity Board, Town Hall, Manchester. Thurs., Dec. 20, 6 p.m.

Incorporated Plant Engineers

BLACKBURN
"Feedwater Treatment," by D. Warburton. Blackburn Branch. Golden Lion Hotel, Blackburn. Thurs., Dec. 20, 7.30 p.m.

GLASGOW
"Heating and Ventilation of Factories," by D. T. Jenkins. Glasgow Branch. Scottish Building Centre, 425/427 Sauchiehall-street, Glasgow, C.2. Tues., Dec. 18, 7 p.m.

ROCHESTER
"Plant Planning and Development," by A. W. Western. Kent Branch. King's Head Hotel, High-street, Rochester. Wed., Dec. 19, 7 p.m.

SOUTHAMPTON
Discussion on "Ship Construction." Southern Branch. Polygon Hotel, Southampton. Wed., Jan. 2, 7.30 p.m.

Institute of British Foundrymen

BRADFORD
"Pressure-Cast Aluminium Pattern Plates," by H. Howlett. West Riding of Yorkshire Branch. Technical College, Bradford. Sat., Jan. 5, 6.30 p.m.

IPSWICH
Film Evening. East Anglian Section. Public Library, Ipswich. Tues., Dec. 18, 7.30 p.m.

Institute of Marine Engineers

BRISTOL
Film Evening, including film of "S.S. British Sovereign." West of England Section. Grand Hotel, Bristol. Mon., Dec. 17, 7.30 p.m.

Institute of Metals

LONDON
"The Metallurgical Challenge of Nuclear Power," by Dr. H. K. Hardy. London Local Section. Thurs., Jan. 3, 6.30 p.m.*

Institute of Petroleum

LONDON
Symposium on "Staff Training." Wed., Jan. 2, 5.30 p.m.*

Institute of Refrigeration

LONDON
"Thermal Properties of Heat Insulation at Low Temperatures," by M. J. Hickman. Junior Institution of Engineers, Pepys House, 14 Rochester-row, S.W.1. Thurs., Jan. 3, 5.30 p.m.*

Institute of Road Transport Engineers

LONDON
"The Use of Plastics in Road Transport," by M. D. Curwen. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Thurs., Dec. 20, 6.30 p.m.

LEEDS
"Exhaust Brake Design and Operation," by A. G. Slee and W. K. Cox. Yorkshire Centre. Great Northern Hotel, Wellington-street, Leeds. Thurs., Dec. 20, 7.30 p.m.

Institution of British Agricultural Engineers

ABERDEEN
"Application of Hydraulics to Agricultural Machinery," by J. C. McNeice. Scottish Centre. North of Scotland College of Agriculture, Aberdeen. Wed., Dec. 19, 7.30 p.m.

Institution of Civil Engineers

LONDON
"Post-War Developments in the Coal-Mining Industry," by Andrew Young, H. A. Longden and B. L. Metcalf. Tues., Dec. 18, 5.30 p.m.*
"Organisation and Control of Highways Maintenance," by W. J. Hiscock. Road Division. Tues., Jan. 8, 5.30 p.m.*

LEEDS
"Design of Horizontal Flow Circular Settling Tanks," by J. D. Thomson; and "The Opening Out and Re-Decking of Burnigill Tunnel," by F. Jenkins. Yorkshire Association. Hotel Metropole, Leeds. Wed., Dec. 19, 6.15 p.m.

Institution of Electrical Engineers

LONDON
Discussion on "Breakdown in Dielectrics," to be opened by C. G. Garton and J. H. Mason. Measurement and Control Section. Tues., Dec. 18, 5.30 p.m.*
"Choice of Insulation and Surge Protection of Overhead Transmission Lines of 33 kV and Above," by A. Morris Thomas and D. F. Oakeshott. Supply Section. Wed., Dec. 19, 5.30 p.m.*
"A Theoretical and Experimental Investigation of Anisotropic-Dielectric-Loaded Linear Electron Accelerators," by R. B. R. Shersby-Harvie, L. B. Mullett and others. Joint Meeting of Measurement and Radio Sections. Tues., Jan. 8, 5.30 p.m.*

BELFAST
"New Developments in High-Frequency Electric Motors," by C. Snowden. Northern Ireland Centre. Engineering Department, Queen's University, Belfast. Tues., Jan. 8, 6.30 p.m.

BIRMINGHAM
Discussion on "Recruitment to the Engineering Profession." South Midland Centre. James Watt Memorial Institute, Great Charles-street, Birmingham. Mon., Jan. 7, 6 p.m.

Institution of Engineering Designers

LONDON
"The Demands of Standards on Engineering Design," by E. W. Greensmith. Thurs., Jan. 10, 6.45 p.m.

Institution of Engineers-in-Charge

LONDON
"Automatic Level Control in Boilers," by C. G. Scolding. St. Bride Institute, Bride-lane, Fleet-street, E.C.4. Wed., Jan. 9, 6.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Experiences with Welded Hulls," by J. Turnbull. Tues., Dec. 18, 6.30 p.m.

Institution of Heating and Ventilating Engineers

LONDON
"Mechanical Services in the Central Area of London Airport," by R. E. Tully. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., Jan. 9, 6 p.m.*

GLASGOW
"Heating and Ventilating of Factories," by D. T. Jenkins. Scottish Branch. Scottish Building Centre, 425/427 Sauchiehall-street, Glasgow, C.2. Tues., Dec. 18, 7 p.m.

LEEDS
"Fuel Economy and Efficiency," by J. C. Stainton. Yorkshire Branch. Griffin Hotel, Leeds. Wed., Dec. 19, 7.30 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 3927.)
British Interplanetary Society, 12 Bessborough-gardens, London, S.W.1. (TATe Gallery 9371.)
British Kinematograph Society, 164 Shaftesbury-avenue, London, W.C.2. (TEMple Bar 8915.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Diesel Engineers and Users Association, 19 Old Queen-street, London, S.W.1. (TRAfalgar 5597.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave-square, London, S.W.1. (BELgravia 3291.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Refrigeration, New Bridge Street House, New Bridge-street, London, E.C.4. (CENtral 4694.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of British Agricultural Engineers, 6 Buckingham-gate, London, S.W.1. (TATe Gallery 8589.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Engineers-in-Charge, 100 Earlsfield-road, London, S.W.18. (BATtersea 1394.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Locomotive Engineers, 28 Victoria-street, London, S.W.1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James' Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. (LANgham 3802.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Leeds Metallurgical Society, Apply to Dr. P. Feltham, The University, Leeds, 2.
Physical Society, 1 Lowther-gardens, South Kensington, London, S.W.7. (KENsington 0048.)
Plastics Institute, 6 Mandeville-place, London, W.1. (WELbeck 5439.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Microscopical Society, Tavistock House South, Tavistock-square, London, W.C.1. (EUSton 2048.)
Sheffield Metallurgical Association, 66 Ringstead-crescent, Sheffield 10. (Sheffield 62144.)
Society of Chemical Industry, 14 Belgrave-square, London, S.W.1. (BELgravia 3681.)
Society of Instrument Technology, 20 Queen Anne-street, London, W.1. (LANgham 4251.)
South Wales Institute of Engineers, Park-place, Cardiff. (Cardiff 23296.)
West of Scotland Iron and Steel Institute, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)

NEWCASTLE-UPON-TYNE
Brains Trust Meeting. North East Coast Branch. North of England Institute of Mining and Mechanical Engineers, Neville Hall, Westgate-road, Newcastle-upon-Tyne, 1. Mon., Dec. 17, 6.30 p.m.

Institution of Locomotive Engineers

LONDON
"Some Considerations on the Problem of Heating British Railways Coaches," by F. J. Pepper. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., Dec. 19, 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
Discussion on "Case Studies from the Application of Planned Maintenance." Industrial Administration and Engineering Production Group. Tues., Dec. 18, 6.45 p.m.*
Discussion on "New Techniques in Photoelasticity." Applied Mechanics Group. Wed., Jan. 2, 6.45 p.m.*
"An Experimental Investigation of the Process of Expanding Boiler Tubes," by Dr. J. M. Alexander and Professor Hugh Ford. Meeting in conjunction with the Applied Mechanics Group. Fri., Jan. 4, 6 p.m.*
BRISTOL
Discussion on "Practice Arbitration." Western A.D. Centre Royal Hotel, Bristol. Thurs., Jan. 3, 6.45 p.m.
SWINDON
"The Experimental Turbo-Diesel Locomotive," by F. L. Picard. Western Branch. Swindon Technical College, Swindon. Tues., Dec. 18, 7.30 p.m.

Institution of Mining and Metallurgy

LONDON
"A Field Method for the Rapid Estimation of the Oxides of Niobium and Tantalum in Black Sand Concentrates," by H. C. Curwen; and "Laboratory Studies on the Beneficiation of Some Ferruginous Manganese Ores of India for the Production of Ferro-Manganese," by P. L. A. Narayanan and G. V. Subramanya. Geological Society, Burlington House, Piccadilly, W.1. Thurs., Dec. 20, 5 p.m.*

Institution of Production Engineers

LONDON
"Production of a Technical Journal," by R. Hutcheson. Royal Empire Society, Craven-street entrance, Strand, W.C.2. Thurs., Dec. 20, 7 p.m.
DERBY
"Technique and Application of Tungsten Carbide," with film, by F. H. Bates. Derby Section. Derby and District College of Art, Green-lane, Derby. Mon., Dec. 17, 7 p.m.
NEWCASTLE-UPON-TYNE
Film Display. North Eastern Section. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Dec. 17, 7 p.m.
NOTTINGHAM
Graduates' Meeting. Nottingham Section. Victoria Station Hotel, Milton-street, Nottingham. Wed., Jan. 2, 7 p.m.
SOUTHAMPTON
"Transfer Machining," by A. J. Sephton. Southern Section. Polygon Hotel, Southampton. Thurs., Dec. 20, 7.15 p.m.
STAINES
"Application of Accurate Measurement to Engineering Production," by J. Loxham. Reading Section. Social Club, Petters Ltd., Staines. Thurs., Jan. 3, 7 p.m.

Institution of Structural Engineers

BRISTOL
"The Advantages and Disadvantages of Structural Steelwork, Reinforced Concrete and Prestressed Concrete," by Donovan H. Lee. Western Counties Branch. New Engineering School, The University, Bristol. Fri., Jan. 4, 6 p.m.

Junior Institution of Engineers

LONDON
"The J.I.E.: Past, Present and Future," by J. Foster Petree. Fri., Dec. 21, 7 p.m.*

Leeds Metallurgical Society

LEEDS
"Some High-Temperature Properties of Copper Alloys," by Dr. J. P. Dennison. The Large Chemistry Lecture Theatre, The University, Leeds, 2. Thurs., Jan. 3, 7.15 p.m.

Physical Society

LONDON
"Thermal Properties of Heat Insulation at Low Temperatures," by M. J. Hickman. Low Temperature Group. Junior Institution of Engineers, Pepys House, 14 Rochester-row, S.W.1. Thurs., Jan. 3, 5.30 p.m.*

Plastics Institute

LONDON
"Plastics and the Engineer," by J. Butler. Lecture for young people. Church House, Westminster, S.W.1. Wed., Jan. 2, 2.30 p.m. (Admission, gratis, by ticket.)

Royal Aeronautical Society

LONDON
All-Day Symposium on "Transonic Wind Tunnel Testing Techniques." Introductory papers by H. F. Vessey, R. Hills, J. A. Kirk, F. O'Hara and F. E. Roe. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., Dec. 20, 10 a.m. (Admission by ticket.)
"Experiences of an Airline Pilot," by Captain O. P. Jones. Lecture for young people. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Thurs., Jan. 3, 3 p.m.

Royal Institution

LONDON
"Photography," by Dr. H. Baines. Six lectures for young people. Thurs., Dec. 27; Sat., Dec. 29; Tues., Jan. 1; Thurs., Jan. 3; Sat., Jan. 5; and Tues., Jan. 8, at 3 p.m. in each case. (Admission by ticket.)

Royal Meteorological Society

LONDON
Various short papers. Wed., Dec. 19, 5 p.m.*

Royal Microscopical Society

LONDON
"Some Applications of Polarisation Microscopy," by Dr. N. H. Hartshorne. Wed., Dec. 19, 5.30 p.m.

Sheffield Metallurgical Association

SHEFFIELD
Annual General Meeting of the Methods of Analysis Group, and Chairman's Address by W. Wright. B.I.S.R.A. Laboratories, Hoyle-street, Sheffield, 3. Tues., Jan. 8, 7 p.m.

Society of Chemical Industry

LONDON
"Corrosion Problems in Nuclear Power Production," by A. B. McIntosh. Wed., Jan. 9, 6.30 p.m.

Society of Instrument Technology

LONDON
"Electronic Automation of Machine Tools," by F. T. Lett. 26 Portland-place, W.1. Thurs., Jan. 10, 7 p.m.*
CHELTENHAM
Film evening. Cheltenham Section. The Rotunda, Cheltenham. Mon., Jan. 7, 7.30 p.m.
CHESTER
"*Ad hoc* Instrumentation," by W. C. Heselwood. Chester Section. 5 King's Buildings, King-street, Chester. Wed., Dec. 19, 7 p.m.

South Wales Institute of Engineers

CARDIFF
Various industrial films. Fri., Dec. 21, 6.30 p.m.
"Drifting at Pentreclwydau Colliery," by E. J. H. Nicholas. Thurs., Jan. 10, 6 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
"Metallic Recuperators," by W. Ernest and C. B. Tupholme. Fri., Jan. 11, 6.45 p.m.

CHUCK FOR SCREWED-SHANK TOOLS

Length Adjustment Incorporated

The "Tru-lok" chuck, introduced by B.S.A. Tools, Limited, Small Tools Division, P.O. Box 232, Montgomery-street, Birmingham, 11, is particularly suitable for use with milling machines, but it can also be adapted easily for drilling and any other types of machine which use screwed-shank tools.

The chuck consists of a body with a taper shank, tapped for the machine drawbar, a screwed bush, split collet, locating centre and locking nut. Insertion of a tool is a simple and rapid operation. The chuck body is first fitted to the machine spindle and the drawbar is tightened. Next, the cutter, with the split collet on its shank, is screwed into the bush, to a depth of one or two threads. The assembly of bush, collet and cutter is then inserted into the chuck body, the bush engaging a substantial key which transmits the drive. The locking nut is then screwed on by hand to engage with the front face of the collet, and the cutter is screwed up until it is in contact with the centre carried in the chuck body. Finally, the locking nut is tightened with a spanner, and the complete assembly is ready for use.

DEPTH ADJUSTMENT

The centre is screwed into the chuck body, and locked by means of an Allen screw. It can be adjusted over a distance of approximately $\frac{1}{4}$ in. to accommodate a re-ground tool, or to work to a pre-determined depth; it can also be removed easily for reconditioning. To make the adjustment on the standard model the chuck is first removed from the machine and the locking nut, collet and bush are taken out. The cutter, with the collet in position, is then screwed into the bush until the end of the shank is flush with the back face of the bush. The bush, cutter and collet assembly is then inserted into the body, and the locking nut is screwed up until the collet is seated in the body. Next, an Allen key is used to screw the adjustable centre down until the bush assembly contacts the back face of the collet. The centre is then locked by the Allen screw provided in the body, the chuck is fitted to the machine, and the drawbar is tightened. Finally, the locking nut is tightened with a spanner. A special centre is available at extra cost to enable cutters to be adjusted without having to remove the chuck from the machine.

Two sizes of chuck are available, the smaller one accommodating tools from $\frac{1}{16}$ in. to $\frac{1}{2}$ in. cutting diameter, while the larger size takes tools from $\frac{1}{16}$ in. to 2 in. cutting diameter. Four bushes and four split collets are supplied with the smaller chuck, three bushes and collets with the larger.

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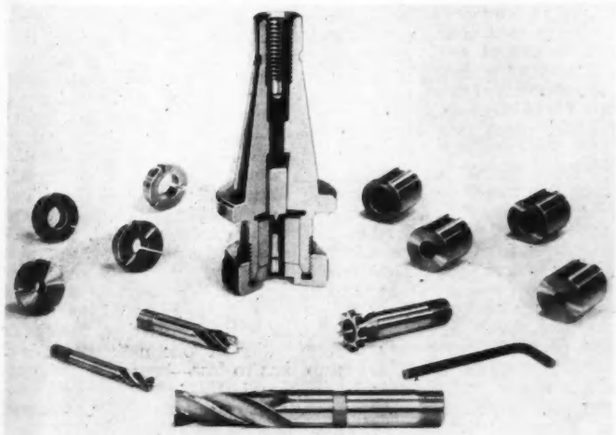

The B.S.A. "Tru-lok" chuck takes all types of screwed-shank tools, which are held by a bush and a split collet. An adjustable centre, visible in the sectioned chuck shown here, enables the effective length of the cutter to be varied.

P.V.C. STACKS FOR NITRIC ACID FUMES

Shown in the accompanying illustration is a row of 11 polyvinyl chloride stacks installed by Plastic Constructions Limited, Birmingham, for extracting nitric acid fumes at the works of the steel manufacturers, Samuel Fox and Company, Limited, Stocksbridge. The stacks are made in Cobex rigid vinyl sheeting, a product of BX Plastics Limited, Higham Station-avenue, Chingford, London, E.4, which is particularly suited to resist the effects of weathering and corrosion, and does not require frequent cleaning and repainting.

THE REALITY

Here is a review of the positive steps that are being taken throughout Britain to encourage more school-leavers to take up engineering as their chosen profession. It has been prepared by ENGINEERING *in the belief that a comparison of what is being done and what ought to be done (as advocated by Sir Ewart Smith in the report on the opposite page) will show up the weaknesses and lead to an extension of present action.*

The need for more engineers has been recognised for at least ten years—since the Barlow report in 1946—and it has been emphasised by every Government committee and every other national organisation concerned with the problem. The natural inertia of a democracy, however, has not encouraged action on a national scale. A direct lead from the Government has been lacking, apart from finance for the universities and similar provisions, which help to educate more young men who have decided to become engineers but which have little or no effect on the number who make this decision. Any idea of "directing" boys to become professional engineers is not even considered—and rightly so—but it might be thought that a national campaign to enlighten parents, teachers and others would be desirable. It has been left to commercial interests to do something.

At what age can or should a boy be influenced? It should certainly be before he reaches the General Certificate of Education age, for after this he must begin to choose his subjects of study to suit the career for which he is aiming. Industrial firms are rather limited in what they can do directly at this stage, though many welcome visits from 11-year-olds to their works. The same audience, however, can be approached through exhibitions, of which there are now two regular examples in London—the National Schoolboy's and Senior Students Own Exhibition, which has been a popular feature of many a holiday, and a newcomer, the Boys and Girls Exhibition, organised by the Hulton Press, which during the 11 days it was open this year had over 227,000 visitors. The Model Engineer Exhibition, though not directed specifically to boys, draws them in considerable numbers.

A spokesman on a British Railways stand said that they probably had more "good" inquiries at the Schoolboys Exhibition than at the Boys and Girls Exhibition, as the average age of those attending it was somewhat higher; he added, however, that much useful literature had been passed on to the younger children (he estimated the average age as 11) which he hoped would bear fruit in the future. In particular, they were trying to emphasise the variety of experience which could now be gained on the railways, especially with the extension of Diesel and electric traction under the modernisation scheme. The opinion about age was confirmed by one of the representatives on Vickers-Armstrongs' stand, but here again an enormous quantity of leaflets had been distributed. The point was also made that parents could be reached in this way, perhaps more easily than any other. British European Airways, in their search for technicians and apprentices, handed out over 41,000 leaflets at one exhibition. The effect of such mass distribution (and there are many firms engaged in it), is difficult to assess. It creates a background and undoubtedly has a long-term effect. Many firms, however, believe that it is best to concentrate on a more direct approach.

Since there are so many grades of engineer and the conditions are different for each, attention may be focussed on the grade which appears to offer the greatest difficulties (and therefore to be in greatest demand), namely the professional engineer holding technical or academic qualifications.

Some firms arrange with schools for a speaker to give talks on engineering in general—its history, structure and practice—and, in particular, what his own firm has to offer. English Electric, the Brush Group, G.E.C., C. A. Parsons, Metropolitan-Vickers—all have such a service, with or without supporting films, and all make considerable use of it. The headmaster of a public school, commenting on talks given to the science societies of schools, says: "They are quite effective. I would mention here only one specific point, namely that it is essential to stress the professional status of engineering as a career. Boys, in public schools at any rate, are very much attracted by professional status, and many who would still not want to go into commerce or industry would feel quite happy about the engineering profession, provided, of course, that it were referred to as such"—an apt remark for a period when the man who tightens a nut is often called by the same name as the designers of atomic power stations.

While at school (particularly boarding school) the outlook of a boy is inevitably influenced by his teachers and surroundings. This opening is not neglected by firms, and it is to careers masters, headmasters or science masters that they send copies of their recruiting literature. In the case of larger firms, masters are invited to attend regular "schools" at the works, where they can see what is going on and discuss their problems with the firm's staff. Examples of these schools are the courses given by Metropolitan-Vickers at Manchester. A recent survey by the English Electric Company suggests that as high a proportion as 50 per cent. of their recruits were influenced by advice given to them by masters.

Visits to works also play a large part in introducing boys to the practical side of engineering, and are usually a regular feature of engineering and science societies at schools. Travelling and other costs in arranging such visits present difficulties. This point was brought out by a headmaster who said "Firms that offer visits are very generous in their provision of hospitality once the party from the school has arrived. But they often forget the desirability of paying, if they can, for fares. Boys at public schools are usually short of money and if the alternative is 5*s*. for a railway fare or 5*s*. for the tuckshop, they normally prefer the latter."

What might be called "extended visits" are the schoolboy vacation courses arranged by some firms. They are somewhat akin to the vacation courses which form part of the training of most engineering students, but are of considerably shorter duration. Those held by the General Electric Company, Metropolitan-Vickers and English Electric last a week. During that week most of the mornings are spent at work in the factory, mainly in the apprentice school, and the afternoons are devoted to lectures, visits and the like. The boys are drawn from the upper fifth and lower sixth forms. Such courses are often arranged through the Public Schools Appointments Bureau.

Another organisation through which some recruitment is arranged is the Youth Employment Service. Until recently it has been concerned mainly with the placing of craft apprentices, but the field is now widening to include more sixth-form leavers from maintained and direct-grant schools, from which many student apprentices come. One of the limitations of this service would appear to be that it is strictly local in operation, unlike the P.S.A.B. which is a national body.

"Most public school boys are influenced a good deal more in their choice of a career by what is said at home than by what is said at school," a headmaster has said. According to the English Electric investigation referred to earlier, about 45 per cent. of their recruits took the first step as a result of advice from parents, guardians, or friends. Consequently it is important to keep up effective background advertising which reaches the home. More directly, Metropolitan-Vickers mention meetings arranged by the parent-teacher association of a school, at which representatives from industry are invited to speak on careers. Another possibility is a one-day convention, arranged perhaps by a parent-teacher association or by the local Youth Employment Service, at which boys can attend with their parents to meet representatives of firms. Facilities for private talks are advisable.

Such are, briefly, some of the more popular ways adopted by firms in this country for gaining recruits. Are they the best methods of obtaining by "natural selection" the right men for the right jobs when manpower is in short supply?

First, quoting a headmaster, "If a public schoolboy is going to be an engineer he must, in most cases, make two decisions at different stages of his school life: (*a*) He must, somewhere between the ages of 13 and 15, choose to specialise in science rather than arts; (*b*) having specialised in science, he must, somewhere about 17½, then decide to go in for engineering specifically." Thus it is by no means too early to start creating background influence about the age of 10 or 11, for it might also influence those taking the "11 plus" scholarship examinations. (There are some, of course, whose choice of career was made at a very early age; recruitment influences for these are merely confirmatory—it is for the waverers that the great efforts must be made). The main line of attack at this first stage would seem to be by visual means—exhibitions and pictorial literature. Professional status must be stressed as it carries great weight in the home.

Next come school influences—from the masters, visits, lectures and films. The aim now must be more specific, so that the choice will not be just "science" but, in due course, "engineering." At this stage, the major efforts of firms begin, and here also the first indications of another problem appear—competition between firms. It becomes more intense when the boy reaches the later stages of study (unless he has preferred to take a sandwich course), and is almost ready to enter the labour market. At this stage the lectures, films and advice provided by the professional institutions are helpful.

The most ambitious move by industry since the war has been the establishment of the Industrial Fund for the Advancement of Scientific Education, in which some of the leading engineering firms have played a major part. The fund finances the building of science laboratories in schools, such as public schools, which lack the money that goes to State schools. So far, a total of £3,020,000 has been subscribed; the governing committee have allotted £1,775,000 to specific projects; and £38,000 has been paid out.

Apart from the efforts which have been described in this article, there are many local co-operative schemes, usually growing out of the enthusiasm of a few industrialists who band together, form a committee and set about taking action which will influence boys, their parents and teachers in the choice of careers. Indeed the picture presented by a survey of British activity in this field is typical of a country with a strong democratic tradition—action takes place at all levels and in many different ways. Such a solution to our shortage of engineers is admirable in that it ensures that responsibility is decentralised and there is little wasted action. It is deplorable, however, that the brunt of the work is falling on a few enlightened firms. Many more, either singly or collectively, could give a hand. The Government could take up a nation-wide campaign—the urgency of the matter certainly justifies it—but it is at least doubtful whether such a campaign would be properly conducted to ensure the desired result throughout the country. More positive action at a national level is, however, desperately needed. Can this be achieved by a joint committee representing Government, industry, education and other interested parties, or is it better to leave it to the firms which seem to do most of the leading to-day—whether it is in education, research or any other frontier of our national welfare? There is no time to lose—boys of 11 who can now be influenced will not become educated engineers until the end of the 1960's. We need many more engineers before that.

THE VISION

Here is an authoritative view of the change in public opinion, and the initiative required from every professional engineer, if we are to get the number of engineers that will be required in Britain in the next few years. It is an abridged report of the remarks made by Sir Ewart Smith, a deputy chairman and technical director of Imperial Chemical Industries, Limited, at a recent meeting of the Institution of Mechanical Engineers, at which Dr. H. S. Arms gave a paper on the American system of education and training for mechanical engineers, and Professor S. J. Davies gave a paper on the education of engineers in European countries.

This report contrasts with the survey published on the opposite page.

The desperate and growing need of high-level technologists, particularly of engineers and more especially mechanical engineers, is something which we cannot tolerate very much longer. In fact, I am not sure that we are not now almost at the point of no return.

This is a problem that the country as a whole is just beginning to recognise, but it is one that nationally we have hardly started to solve. For example, my own organisation currently takes some 250 graduates of all types—chemists, physicists and engineers—a year, and we should like more if we could get them. We try to cast our minds into the future, and in doing that it is our estimate that in 25 years' time, if we are to hold our own by world standards, we shall want four times that number—that is, a thousand a year. Similarly, all other branches of industry which now have an appreciable intake will require more, and those which now take few people of this type will have to increase greatly their numbers under the impact of technical advance. To me, therefore, this problem of supply is of basic and fundamental importance.

If we keep to first degrees, in 1954 in the United Kingdom we produced 57 engineering graduates per million of the population. The United States had 137; and they are desperately worried and dissatisfied with that figure. The U.S.S.R. had 280; and those of us who have had contacts recently with the Russians, and particularly those members of this and of our sister Institutions who have been to Russia, would, I am sure, be the first to say that the quality of the Russian output of graduate-type people from their institutes is at least as good as that in any other country. That indicates the disquieting position in which we stand, and the Lord President, in the debate in Parliament, said that this was a matter of life and death. I truly believe this is no understatement, but unfortunately the action that we take now cannot bring any real progress quickly; that is something that is often overlooked.

I had the temerity in 1950 to suggest that there was a direct relation between industrial progress and the number of technologists in the country. I suggested then that the minimum we ought to aim at was a 5 per cent. increase—a compound interest increase—per annum. At that time, that would have meant, in effect, starting a new institution of university status at least every second year as far as applied science is concerned. Professor Davies has told us that instead of going on from that time, we have actually gone back. My own feeling now is that the minimum we ought to aim at is 10 per cent. per annum; but knowing the ignorance, complacency and conservatism which exist what hope have we of getting it?

As I see it, to get the expansion that I believe to be vitally necessary, the first need is teachers in the schools; and secondly, teachers in the institutions of higher education. The Russians, from their huge output of engineering and science graduates, are taking 20 per cent. per annum to teach. They are ensuring the supply of eggs to hatch more geese to lay more golden eggs.

Secondly, I believe the essential need is to see that we attract the right type of adolescent —young men or women—to this sort of work, and in the right numbers. This brings one straight up against a point which Dr. Arms mentioned: the question of public esteem. It is an old tag, for instance, that Whitehall wants engineers and scientists—it wants them on tap and not on top.

I heard some few years ago a discussion that was taking place on this very subject. The headmaster of a well-known public school said, " Yes, of course, I would like to see more of my boys going on to the science side, but there is an awful difficulty because it means that they have to leave the intellectual aristocracy of the school." These attitudes are a reflection of the lack of understanding which still exists in this country, and I ask you, gentlemen, where is it likely to lead us ?

Thirdly—and I put this very much last—in order to get improvement one must have better facilities. Unfortunately, what do the Government do ? They are going to provide, relatively speaking, a considerable sum of money for facilities—and nobody likes nice facilities in the way of buildings, equipment, and so on, more than I do. Good facilities and good buildings are one side of a vigorous, buoyant civilisation—we have seen that throughout history; but when one is in desperate straits, would not much of this money put to teachers' salaries achieve infinitely more than the same sum put to the provision of buildings?

In Russia—again, I want to copy no one; I am prepared to learn from anyone—they are equally short of buildings, but do they let that stop them ? No; they use them on shift. During the post-war bulge in the universities the Americans did much the same. I know that some of my academic friends may hold up their hands in holy horror at the suggestion, but as I see this position it really is now getting desperate, and it is that sort of action that has got to be taken. But what is the good of having shifts in your existing buildings, some of them very good, if you have not got the teachers ? That is why I put teachers at the top of the list.

I am not, I hope, by nature a pessimist, but in this matter, unless within the next few years—I mean one, two or three years—we can get a different approach, frankly I see this country going down and down, relatively if not absolutely. In fact, because all things in the world are relative, because unless we are competitive we cannot buy the materials and food that we want, we shall not go down merely relatively; we shall go down absolutely.

What do we need to do to effect improvements in the courses and training we give our graduate-type engineer ? I believe, first, that we need to educate the adolescent, to have more balance and a broader approach. I believe that we should fight desperately hard against the growing curse of early specialisation, because it turns out humanists who have not the foggiest notions of Newton's laws of motion or what makes the modern world tick. It turns out technical people who in many cases can hardly write the English language; and in questions of philosophy, leadership or management they do not have the broad basic background on which a proper approach can be made.

And so I plead for a drive in the schools for breadth and balance, and for far less specialisation. In that, of course, the universities, in the examinations which they set for entrance and for scholarship, really have the main key under their own control. They often appear to be over-obsessed with research and with the desire to attract the few people of the type who might write papers for the Royal Society. Thus there is an insistence on picking people from the schools who are crammed so that they start on their disciplines knowing far more than they ought to know about specialised subjects and far too little about other important fields of general knowledge.

Secondly, we ought to concentrate far more on teaching the adolescent, or the young man or woman at the university, to think fundamentally, to be grounded in principle, to be taught how to use knowledge rather than to have knowledge. That is going to be forced on us whether we like it or not. With a growing flood of factual knowledge, not for very much longer can we even attempt to turn the rising generation into little walking encyclopaedias of knowledge that anyway is out of date before they can have the opportunity of using it.

Thirdly, we have got to select and train for the top-flight people those who are, or can be induced to be, dynamic and can achieve effective results. We all know—we all regret—the high percentage of boys who are received into the universities in most cases purely on written examinations, very often on questions based on factual knowledge, who fail to stick the course because they are not of the right type and fundamentally they have not been properly trained, certainly not properly selected. Unless the individual has, in fact, been trained to reason logically and constructively from fundamental principles, he will never become a really good engineer, whether judged by academic standards or from the more searching tests of his professional career.

I agree, too, that we should examine most carefully whether the continuing over-insistence on a prolonged period of practical training is not out of accord with modern thought and modern needs. There are some people who will benefit from two years; there are some for whom, if you give them more than three or six months, it is a wicked waste of time which could be better employed in other directions.

Of course, if one follows this sort of line, if you concentrate much more on principle at the undergraduate stage, you will say " Where do we get our real top flight who will pursue the bounds of knowledge? " My answer to that is that real advanced specialisation should mainly be a matter of the man's industrial career, linked with post-graduate courses, which to my mind are best taken after some experience in industry, of both a practical and managerial nature.

Do not, please, infer from what I have said that I am a disbeliever in practical experience. I would say that every man who is going to occupy a managerial position—and I use the term " managerial " very widely; I say that the trade union leader or the schoolmaster or a Government official has a managerial responsibility—should for a portion of his training period be a workman, because it is only by being a workman that one gets the opportunity of seeing management from the other side—and how different it often looks !

I am not appealing for us in this country to copy anyone. I am appealing for us to be self-critical, to have open minds and to see whether we can learn from other people in this way or that, as I believe we can. I am appealing for us as a nation to realise the inevitable trends, and how fast the trend is changing, and that we should take time by the forelock before it is too late.

If every member of this Institution, even if everybody here tonight, would go out and examine his own attitudes, the attitudes of his own organisation and his own thinking, fearlessly and honestly, and ask himself whether he is really satisfied with the present position and, if he is not, if he will say " As a Briton, I have a job of work to do that is vitally important "—if everybody does that, then I believe that we have the innate ability, that in spite of everything we still have the courage, and that we can generate the vision and we can take the action which, please God, will remove us from the declining slope that you have been shown tonight. Instead we can again tread the rising path where, in this rapidly changing, accelerating technological world, we can at least hold our own and, small as we may be relatively speaking, maybe we can once more lead.

THE HUMAN ELEMENT

National service training for young scientists in the United States—Recruitment in the little-ship yards—The permanent civil servant's superannuation privileges—A little automation goes a long way—E.D.A.'s film on home sales.

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Scientists out of Military Service

A new method of fulfilling military service obligations has been started in the United States and may prove an important source of highly skilled engineers. The issue of November 14 of the Engineering and Scientific Manpower newsletter—produced jointly by the Engineering Manpower Commission of Engineers Joint Council, New York, and the Scientific Manpower Commission, Washington—contains the first statistics relating to what is called the "special skills reserve programme." This is primarily designed to apply to engineers and scientists who have had their call-up deferred and consists of six months' intensive training to take the place of the two years of regular military service.

Some 1,200 applications were received by the Selective Service organisation for the first course and, of those examined by the administration, only 8·7 per cent. were rejected. Of the approved candidates, 54 per cent. were professional engineers and nearly 10 per cent. engineer draughtsmen. Most of the remainder were chemists and school teachers. There is a classification of "essential activities" among which the successful candidates are distributed. Of the first batch, nearly 37 per cent. were allocated to research and development, presumably of a defence character. The most important other categories were aircraft manufacture, electronic and communications equipment, ordnance, chemical and allied products and teaching. The Selective Service officials point out that nearly 25,000 deferred men will have to choose, at the age of 24 or 25, between six months under the special skills reserve programme or being called for military service.

This new method of getting engineers and scientists to make their contribution to the national defence effort would seem to be most sensible both from the point of view of the men, their employers and the defence authorities. It avoids the "waste" of two years general military training, which modern war makes even less necessary than before for the specialist, and provides a reserve of first-class men—presumably the cream of the profession—trained in the Services' special requirements. This scheme is to be strongly commended to Whitehall.

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A Craftsman's Career

Small craft are built by craftsmen, and the industry which produces yachts, boats, launches, tugs and other types of boats and small ships badly needs more craftsmen and more apprentices. The Ship and Boat Builders' National Federation have recently published a booklet entitled *A Craftsman's Career in the Small Ship and Boatbuilding Industry*, which gives a very good picture of the type of skills the industry requires. H.R.H. The Duke of Edinburgh, whose introductory letter prefaces the booklet, writes ". . . the boy who decides to make a career in the small-craft building industry can be confident that he will be taught a trade that is as old as the hills and likely to be just as permanent." The last few words are the operative ones. Never, say the Federation, will the craftsmen in this industry be displaced by machines.

Never is a dangerous word for common mortals to use, but no greater assurance of permanence is offered in manufacturing industry except perhaps by the craft of pattern making. The decline of entrants to the craft industries since the war constitutes one of the main problems of the traditional industries of Britain. The reason is not far to seek: pay is generally lower, and advancement less rapid. So long as an apprentice has to pay a premium, in the form of less earnings than possible elsewhere as an unskilled or semi-skilled worker, recruitment will be difficult. The remedy is equally obvious: if a high degree of skill is indispensable, as in this case, then the price of the product should be allowed to find its own level, at which the industry could afford to pay a rate competitive with other industries. There is no other way.

Sentiment is necessary to our lives, and a great deal of it is attached to the building of boats. Yet it is bad business for this country to have boys capable of highly skilled work in an industry where their value cannot be translated into cash. Hard words perhaps, but also hard to refute.

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Civil Servant's Superannuation

Feelings are running high among the Staff Side of the Civil Service on the subject of superannuation. A full-blown campaign, supported by public meetings, had been organised for last month but was called off on the grounds that it might have been identified with the demonstrations against the Government following the action on Suez. The leading article of the December issue of State Service, the journal of the Institution of Professional Civil Servants, makes it plain that the demonstration has only been postponed. The National Staff Side are very angry about the Government's failure to allow temporary service to count in full for superannuation purposes. *State Service* suggests that the Government did in fact mislead the Staff Side with "a series of moves calculated to deceive." They argue that had the Government made it plain at the outset that it could not contemplate any action on the Royal Commission's recommendations on superannuation "there is little doubt that the course of the negotiations on pay and on hours and leave would have been materially different."

In a letter published in the same issue of the journal, the Chancellor of the Exchequer indignantly rejects the Staff Side's charges of bad faith on the Government's part and goes on to justify the official attitude. Following as it did immediately upon the Staff Side's decision to postpone their campaign, the letter is taken as an opportunist move on his part made "at the first sign of slackening pressure." The Civil Servants leave no room for any doubt that the pressure will soon be renewed, with even greater determination.

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Mounting Expenditure of Trade Unions

Trade unions are spending more than their members' total contributions but income from investments restores the balance and adds to the union funds. This was stated in the report of the Chief Registrar of Friendly Societies, which gave some interesting statistics of union finance. Covering 405 unions with an aggregate membership of 8·5 million at the end of last year (only registered unions are included) the report indicates that at that time union funds stood at £76·6 million; an average of £9 a head as against £8 17*s.* the previous year. Total expenditure per member averaged 46*s.* out of which strike pay took only 1*s.* 7*d.*

The net addition to union funds came entirely from the £2·7 million income derived from "sources other than contributions," the bulk of which is presumably income from investments. This is not a healthy state of affairs, especially if a high proportion of union funds are invested in gilt-edged or other securities that tend to lose some of their capital value as the pound sterling depreciates. Sooner or later—and for the sake of the trade union movement, the sooner the better—the unions will have to spend more on their staff. They must be prepared to pay the kind of salary that attracts first-class administrators and specialist advisers. Research in management techniques, such as method study, is an investment which deserves a high priority. Yet the proportion of contributed income which goes on keeping the unions running and on paying their officers already amounts to 11*s.* 9*d.* in the £. The obvious solution is to raise contributions, but in days of rising prices and falling overtime earnings this would have an adverse effect on membership and certainly would not be popular.

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Spread of Automation

The Chief Inspector of Factories, Sir George Barnett, suggests in his report for 1955 that mechanisation and automatic control of factory processes are becoming more and more widespread. The Chief Inspectors' views on this subject—no-one can have the same broad knowledge of what is taking place in manufacturing industry—are that a very large number of relatively small changes in that direction are having a cumulative effect on production and on working conditions much greater than the more obviously impressive example of full automation in the larger plants. The report leaves no doubt that the effect is becoming considerable.

Sir George says that control mechanism should have the characteristics necessary for safety, and recommends that this should be done in the initial stages of design. He offers the advice of his Department in these matters.

The analysis of accidents is exceedingly thorough and done from a practical standpoint which should help those concerned with safety arrangements. A point stated with particular emphasis was that "unless a genuine and continuing interest in accident prevention was shown by top management, accident prevention schemes, however excellent on paper, were doomed to stagnation and ultimate failure.

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Creeping up on Sales Resistance

The art of talking about something quite different from what she has in mind is considered one of woman's most formidable weapons. Placing your dinner on the table, she inquires how it's been at the factory and whether you've solved that problem of work study yet. "Yes," you say, "quite simple really," and begin to explain, concluding with a little homily on being up to date and the importance of reducing human effort. With a smile she pays tribute to your remarkable ingenuity, following up quickly with an apology about dinner being late—"Washday, you know." Then quickly back: "What was it you said about being up to date?" Lulled, you allow the conversation to proceed. And suddenly you find yourself saying: "What you need is a washing machine."

The oblique approach is adopted in a film made for the British Electrical Development Association (E.D.A.), 2 Savoy-hill, London, W.C.2, by Mr. Cecil Musk, in association with the Film Producers' Guild. Entitled "How to Sell your Husband a Washing Machine," it is in colour with sound and lasts for 18 minutes; both 16 mm. and 35 mm. versions are available. Washing machines get scarcely a mention for some time; the aim seems to be rather to engender in the audience a state of fascinated hypnosis so that when the moment arrives, they are, like Titania, open to any suggestion. This service is rendered by Miss Cicely Courtneidge and Mr. Jack Hulbert with great charm and humour from a script that is both fast and witty. The advertising film is sometimes looked upon as a necessary evil in a cinema programme, but a film like this puts many feature films to shame. The makers are clearly aware that to persuade your audience you need their sympathy; and how better to win their sympathy than by entertaining them?

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